Understanding the Impact of the Consolidation of Surgical Services in a Major Integrated Health Region

Technical Report

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(On behalf of the Surgery Consolidation Study Group)

April, 2003

Alberta Centre for Health Services Utilization Research

ACKNOWLEDGEMENT

The authors gratefully acknowledge the support provided by the Alberta Centre for Health Services Utilization Research, which conducts studies of how health services are used and delivered to inform health policy development and management of health service delivery. The Alberta Centre for Health Services Utilization Research is a joint initiative between the University of Alberta and the University of Calgary, funded by Alberta Health and Wellness. ***The opinions and conclusions expressed in this paper are those of the authors and no endorsement by Alberta Health and Wellness is implied.***

The authors also wish to thank Alberta Health and Wellness for use of its administrative health services data.

Finally, we wish to acknowledge the contribution made by the following researchers and staff that formed the Advisory Group for the overall project:

- Dr. Robert Bear – University of Alberta
- Chris Houston – Edmonton Capital Health
- Kathleen Ness – Edmonton Capital Health
- Kathy Trepanier – Edmonton Capital Health
- Dr. Olive Triska – University of Alberta
- Mary Ann Zupancic – Edmonton Capital Health

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ISBN: 0-7785-2403-5
http://www.health.gov.ab.ca/system/key/Research/achsur_reports.html

Summary of "Understanding the Impact of the Consolidation of Surgical Services in a Major Integrated Health Region"

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Purpose

In July 1995, the Royal Alexandra Hospital and the University of Alberta Hospital began to provide all the high intensity surgical procedures in the Edmonton Capital Health (ECH) region. Community hospitals in Edmonton Capital Health focused solely on low-intensity services. The purpose for consolidation was to reduce costs and increase efficiency. This study examines the impact of the consolidation of surgical services in ECH on patient access to surgery, wait times and rates of complications.

Approach

Using Alberta Health and Wellness administrative data, nine high-intensity and seven low-intensity procedures were assessed from pre-consolidation to post-consolidation. The analyses were made for ECH and comparison regions (the Calgary Health Region and other RHAs in Alberta) that did not undergo consolidation of surgical services during this period.

Key findings

The following are key findings of this study:

- Volumes of some high-intensity procedures increased following consolidation [craniotomy for tumors (+15%), microvascular free tissue transfer (+15%), nephrectomies (+16%), total knee/hip replacements (+28%)], however, volumes of these same procedures also increased in the Calgary Health Region and/or other health regions. In addition, increased volumes of colon resections that were observed in other regions were not observed in Edmonton Capital Health.
- Volumes of some low-intensity procedures decreased following consolidation [ligation and stripping of saphenous veins (-16%), tubal ligations (-26%), tonsillectomy and/or adenoidectomy (-26%), TURPs (-44%)], however, volumes of these procedures (with the exception of ligation and stripping of saphenous veins) also decreased in the Calgary Health Region and/or other health regions.
- Increases in wait times were observed in ECH for abdominal aortic aneurysms (+39 days) and colon resection for cancer (+19 days), however, there were no corresponding increases in wait times in other health regions. Wait times for total hip and knee replacements (+11 days), laparoscopic cholecystectomies (+20 days) and TURPs (+12 days) also increased, but these

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increases were also observed in the Calgary Health Region and/or other health regions.

- Decreases in complication rates were observed for total hip and knee replacements (-23%) and laparoscopic cholecystecomies (-30%); these were also observed in the Calgary Health Region or other health regions. Complication rates for colon resection for cancer in ECH increased by thirty percent, but did not change in the Calgary Health Region.

Conclusions

Changes in surgical volumes, complication rates and wait times were observed in Edmonton Capital Health for some of the procedures we evaluated. For the most part, similar changes were also observed in the Calgary Health Region and/or other regions and are likely to be attributable to other cost saving measures such as the reduction in the number of hospital beds, shorter lengths of in-patient stays and shifting procedures from inpatient to outpatient settings.

The increase in wait times for abdominal aortic aneurysms and volumes, complication rates and wait times for colon cancer which was seen only in Edmonton Capital Health can be related to factors other than consolidation.

For more information

Copies of the report are available from the **Alberta Centre for Health Services Utilization Research**

- by contacting Duncan Saunders by e-mail at duncan.saunders@ualberta.ca
- at http://www.health.gov.ab.ca/system/key/Research/achsur_reports.html

Alberta Centre for Health Services Utilization Research

The Alberta Centre for Health Services Utilization Research is a joint initiative between the University of Alberta and the University of Calgary, funded by Alberta Health and Wellness. The Centre conducts studies of how health services are used and delivered to inform health policy development and management of health services delivery.

Release date

April, 2003

103-06155/

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SUMMARY

In December 2000, researchers from the University of Alberta and senior decision-makers and managers from Edmonton Capital Health (ECH) Regional Health Authority (RHA) in Alberta embarked on a study to examine the effects of the consolidation of surgical services in ECH on patients, providers, students, and on the health care system in general. This report outlines the findings from our assessment of the impact of consolidation of surgical services on the delivery of surgical services in the region. Specifically, the study looks at changes in access to surgery, as measured by changes in surgical activity and wait times for surgery, as well as changes in quality of care, as measured by changes in rates of complications for sixteen index procedures. Findings for ECH were compared with the Calgary Health Region (CHR) and all other Regional Health Authorities (RHAs).

For the procedures assessed, generally, there were no significant changes in surgical activity for ECH after consolidation that were not observed in other RHAs. Overall, study findings showed that in Edmonton Capital Health, the volume of most high intensity procedures increased after consolidation, while volumes of most low intensity procedures decreased. However, this trend was also observed in the other comparison RHAs. For the surgical programs, generally, there were no significant changes in surgical activity for ECH after consolidation that were not observed in other RHAs. With the exception of one procedure, colon resections, complications rates in ECH fell or stayed the same after consolidation. Generally, waiting times either increased or stayed the same after consolidation. The only procedures for which waiting times increased in ECH and not in other RHAs were colon resections and abdominal aortic aneurysms.

Based on the measures explored, the findings of the study suggest that changes in utilization and outcomes in Edmonton Capital Health following consolidation were similar to changes observed in other regions. Most of the observed changes may be attributable to other health-system changes occurring at this time in Alberta that were not specific to Edmonton Capital Health. This study relied on routinely collected administrative data. Prospectively collected data is needed to evaluate the impact on patients more thoroughly.

INTRODUCTION

Project Overview

In December 2000, researchers from the University of Alberta and senior decision-makers and managers from Edmonton Capital Health in Alberta embarked on a study to examine the effects of the consolidation of surgical services in Edmonton Capital Health on patients, providers, students, and on the health care system in general. The project was an endeavor to apply health services research methodology to provide information to decision-makers on the impact of surgical services consolidation. The objectives of the project were to document the nature and characteristics of consolidation, assess the impact of consolidation on patients, providers. students and the system and investigate alternative approaches to the effective delivery of surgical services.

This report outlines the findings from one component of this project: the assessment of the impact that the consolidation of surgical services has had on patients.

Overview of Consolidation of Surgical Services

Edmonton Capital Health was created by the Alberta Government in June 1994. At that time, there were five acute care hospitals located within its boundaries: the Grey Nuns and Misericordia Hospitals administered on behalf of Edmonton Capital Health by the Caritas Health Group; and the Royal Alexandra, Sturgeon and University of Alberta Hospitals directly administered by Edmonton Capital Health. In April 1998, Edmonton Capital Health acquired a sixth small acute care facility, the Leduc Community Hospital, as a result of a province-wide regional health authority boundary adjustment. Edmonton Capital Health also opened a new North East Community Health Centre in September 1999. Throughout the study period, Edmonton Capital Health provided a full range of surgical services, including: cardiac; ear, nose and throat (ENT); general; neurological; obstetric / gynecologic; oral; orthopedic; ophthalmologic; plastic; transplant; thoracic; urological and vascular surgical services. Edmonton Capital Health serves a population of 816,000 within the boundaries of the RHA and a total population of 1.6 million including referrals from Northern Alberta.

In July 1995, in response to major reductions in provincial funding, Edmonton Capital Health restructured its surgery program. Surgical procedures were consolidated based on their relative intensities. Two of the region's acute care facilities, the Royal Alexandra Hospital and the University of Alberta Hospital, were designated as "referral hospitals" and began to provide all of the high-intensity surgical procedures provided by Edmonton Capital Health. These facilities continued to provide some low-intensity services. The remaining facilities were designated as Community Health Centres

(CHCs) and specialized in providing low-intensity surgery. The aim of this strategy was to reduce the cost of providing health care services as well as to increase the overall efficiency and effectiveness of the system. Consolidation also took advantage of findings that suggest the existence of a "volume-outcome" relationship, where institutions performing higher volumes of high-intensity procedures have better outcomes [1, 2].

In addition to realigning the delivery of surgery along a high- versus low-intensity split of services, Edmonton Capital Health sought to deliver more procedures as day or outpatient procedures, and ensure earlier discharge of acute care inpatients. The following surgical services were consolidated: cardiac, neurological, oral, ophthalmologic, thoracic, transplant, vascular, ear, nose and throat (ENT), general, obstetrics / gynecology, orthopedic, plastics and urological.

Following the consolidation of surgical services, Edmonton Capital Health undertook a series of reviews of the process. From these reviews, it was determined that the existing distribution of surgical services worked reasonably well with the exception of four programs: ENT, orthopedics, urology, and general surgery. In the end, a decision was made to deconsolidate some surgical services. Specifically, some neurosurgical and orthopedic surgery moved to the CHCs, and general and vascular surgery was redistributed between the CHCs and the referral hospitals.

Study Overview

The purpose of this study is to explore the effects that consolidation of surgical services has had on the delivery of surgical services in the region. Specifically, the study looked at the impact on access to surgery, as measured by changes in surgical activity and wait times for surgery, and quality of care, as measured by changes in rates of complications . There is a large body of literature on the evaluation of integrated health delivery systems [3, 4]. However none have studied the impact of consolidating surgical services within an integrated health region. Prior studies of surgical consolidation [2, 5, 6, 7, 8, 9, 10, 11] have primarily focused on the consolidation of individual procedures, and not on an overall system-wide consolidation of surgical services.

The consolidation process was prompted by dramatic reductions in funding for the delivery of health care services. This funding change prompted many other changes at the same time, including the closing of hospital beds, reductions in lengths of stay, and a shift towards providing more day surgeries. This brought with it a challenge to try to measure changes in the delivery of services caused by consolidation within an environment where other rapid changes were also taking place. To attempt to control for these other changes, we sought to compare changes occurring in Edmonton Capital Health with those in other jurisdictions that did not consolidate their surgical services in response to reductions in funding. Specifically, we made comparisons with changes in the Calgary Health Region, a similar RHA with a population of 973,000 within the region and a referral population of 550,000 from Southern Alberta, as well as with changes in

all other RHAs in Alberta combined. The latter RHAs include both urban and rural centres. While not an ideal way of controlling for confounding caused by these other changes, these comparisons allow us to attempt to control for similar changes that were taking place in the other jurisdictions – among them, the closure of hospital beds and the shift towards day surgery procedures.

To measure changes in access to surgical services, we looked at some different measures. The first was surgical activity. Assuming that need remained the same, any dramatic decrease in surgical activity could indicate a negative impact on patient access to surgical services. Within the realm of surgical activity, we looked to see if consolidation was also associated with any changes in lengths of stay. The second measure was adverse outcomes. An increase in adverse outcomes would indicate a negative impact on patient quality of care. Adverse outcomes were measured by looking at rates of in-hospital complications. The final measure was wait times for elective procedures. An increase in wait times would indicate a negative impact on patient access to surgical services. These three measures were chosen as they were easily measured using data that had already being captured by the health system.

METHODOLOGY

Summary of Analyses

The model for the consolidation of surgery in Edmonton Capital Health was based on designating facilities to perform high-intensity or low-intensity procedures. Most high-intensity procedures were moved to the two tertiary teaching hospitals (the University of Alberta and the Royal Alexandra Hospital), while most low-intensity procedures were moved to the community hospitals. To measure changes associated with this model of consolidation, we chose to select and focus on, where possible, one high-intensity and one low-intensity procedure from each program area that was consolidated. However, for some program areas, it was not possible to identify or measure suitable high- and low-intensity procedures. Regional and temporal variations in *surgery volumes, length of stays (LOS), complications, and waiting times* of selected surgical procedures were investigated. Edmonton Capital Health was compared to the Calgary Health Region as well as all other RHAs in Alberta combined. The 1998 RHA boundaries were used. Variations in measures were assessed by fiscal year, as well as, three periods related to the consolidation process: the period before consolidation, the period between consolidation and deconsolidation and the period after deconsolidation (for procedures that underwent deconsolidation).

For this study, we chose to look at fifteen index surgical procedures to assess whether utilization, outcomes and wait times had changed from pre-consolidation to post-consolidation. Since some of these procedures were subsequently deconsolidated, we also sought to measure changes associated with the

post-deconsolidation period. The index procedures of interest are listed in Table A below.

Table A – Dates of Consolidation and Deconsolidation for Procedures of Interest

Program Area	Procedure	Procedure Type	Consolidation Date	Deconsolidation Date
Neurosurgery	Craniotomy for Tumours	High-Intensity	February 1, 1996	November 1, 1999
Obstetrics / Gynecology	Debulking for Ovarian Cancer	High-Intensity	July 1, 1995	
Obstetrics / Gynecology	Tubal Ligations	Low-Intensity	July 1, 1995	
Orthopedics	Total Knee / Hip Replacement	High-Intensity	September 1, 1995	November 1, 2000
General Surgery	Colon Resection for Cancer	High-Intensity	September 1, 1995	November 1, 1998
General Surgery	Laparoscopic Cholecystectomy	Low-Intensity	September 1, 1995	November 1, 1998
Urology	Nephrectomy for Tumours	High-Intensity	July 1, 1995	
Urology	TURP	Low-Intensity	July 1, 1995	
Vascular Surgery	Abdominal Aortic Aneurysm	High-Intensity	July 1, 1995	November 1, 1998
Vascular Surgery	Ligation and Stripping of Saphenous Vein	Low-Intensity	July 1, 1995	November 1, 1998
Thoracic Surgery	Thoracotomy for Tumour	High-Intensity	June 1, 1995	
Plastic Surgery	Microvascular Free-Tissue Transfer	High-Intensity	June 1, 1995	
Plastic Surgery	Reduction Mammoplasty	Low-Intensity	June 1, 1995	
ENT	Laryngectomy for Cancer	High-Intensity	June 1, 1995	
ENT	Tonsillectomy and/or Adenoidectomy	Low-Intensity	June 1, 1995	

Data Sources

Inpatient procedures and resulting complications were identified from the CIHI (Canadian Institute of Health Information) discharge dataset obtained from Alberta Health and Wellness. Day surgery procedures and wait times were identified using the physician claims dataset. The latter is a database of all claims made by physicians for services provided under the fee-for-service system.

Inpatient procedures for patients discharged between April 1, 1992 and March 31, 2000 were selected. Identification of procedures was based on ICD-9-CM procedure and diagnosis codes. All ten procedure fields and all sixteen diagnosis fields were used to capture procedures. Outpatient procedures were extracted from the physician claims data for the period between 1994/1995 and 1999/2000 (1994/1995 was the first fiscal year that complete information on all claims was available). Claims for fee and / or claims adjustments were excluded to avoid double-counting procedures. Outpatient procedures of interest were selected using the Clinical Classification of Procedures (CCP) codes. Since physician claims can be submitted for inpatient procedures, claims

records that matched with inpatient hospital discharge records for the study procedures were excluded from the outpatient analyses. All unmatched claims were classified as outpatient procedures. To allow for inaccuracies in dates of claim submissions for inpatient procedures, claims that were made in a time period from seven days before and up to and including seven days after an inpatient *episode of care* for the same patient and the same procedure were flagged as claims for inpatient procedures and excluded from the outpatient analysis. To avoid overestimating the number of outpatient procedures when multiple physicians are involved with and submit separate claims for a single outpatient procedure, duplicate claims for a patient for the same procedure on the same date were excluded. Reduction mammoplasties were an exception. Up to two claims were allowed in a single day for reduction mammoplasties to capture bilateral procedures that are billed twice as unilateral procedures. Similarly, bilateral reduction mammoplasties performed on inpatients were weighted as two procedures to maintain comparability of inpatient and outpatient volumes.

For this study, we excluded tubal ligations immediately after obstetrical deliveries, partial hip and knee replacements and revisions, partial nephrectomies and the removal of transplanted / rejected kidneys, and partial removal of the ovaries. Ligation and stripping of the saphenous vein, by definition, was specific only to the lower limbs. Tonsillectomies and adenoidectomies were specific to those ages sixteen and under.

Length of Stay and Episode of Care

An *episode of care* for an inpatient procedure consisted of a series of hospitalizations for a single patient with one or fewer day between hospitalizations where the procedure of interest was performed during any of these admissions. In instances where more than one of the same procedure was performed within an episode of care, we treated each procedure as a distinct event and counted it as such.

The LOS for an inpatient procedure was the sum of total days spent in hospital for each inpatient admission within an *episode of care*. To adjust for long term stays, lengths of stays for long admissions were truncated to a LOS of 365 days. LOS was calculated for inpatient admissions only.

In-hospital Complications

In-hospital complication rates were assessed for four procedures: total hip replacements, colon resections, microvascular free tissue transfers and laparoscopic cholecystectomies.

Post-surgical in-hospital complications (within the *episode of care)* were identified using ICD-9-CM diagnosis codes present in any of the sixteen diagnosis fields in the inpatient data. If two of the same procedures within a single episode of care were followed by a complication, the complication was assumed to be the result of the second procedure. Table B lists the complications of interest.

Annual risk adjusted rates of complications were calculated using the number of procedures with at least one complication as the numerator and the total number of procedures of interest as the denominator. The direct method of standardization was used with all patients undergoing the procedure of interest over the entire study period as the standard population. Rates were adjusted for age, sex, elective / non-elective status of procedure, anemia as a comorbidity during the episode of care, and myocardial infarction and / or diabetes within three months prior to the procedure.

Table B – List of In-hospital Complications of Interest

Complications Common to all Procedures	▪ Pneumonia and Aspiration Pneumonia ▪ Deep Vein Thrombosis and Thrombophlebitis of Deep Veins of Lower Extremities ▪ Pulmonary Embolism ▪ Myocardial Infarction ▪ Sepsis ▪ Stroke ▪ Unstable Angina ▪ Wound Infections
Total Hip Replacement	▪ Dislocations ▪ Infections
Colon Resection for Cancer	▪ Intraabdominal Abscess
Microvascular Free Tissue Transfer	▪ Failed Transfer ▪ Vascular complication of flap
Laparoscopic Cholecystectomy	▪ Bile Leak, Cystic duct stamp leakage, Subhepatic collection of fund ▪ Injury to common bile duct ▪ Perforation to common bile duct

Wait Times

Wait times for a procedure were defined as the number of days that patients had to wait for a surgical procedure after the last pre-operative visit with the physician performing the procedure. This is similar to the methodology used by one previous study to measure wait times [12]. Wait times of eleven of the selected procedures were examined and only elective procedures were included in the analysis.

Physician claims data in conjunction with discharge data was used to derive wait times. Wait times were calculated as the number of days between when a claim for an inpatient procedure is made and the claim for the last pre-operative visit with the physician performing the procedure.

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Records for fee and claims adjustments and claims by anaesthesiologists and general practitioners were excluded from the analyses. Where patients had more than one of the same procedures, wait times were assessed for only the first of each of the procedures for each patient. Some inpatient admissions could not be matched to a physician claim; these admissions were excluded from the analyses.

If the claims data indicated that the patient had a visit with the physician a day before the procedure then the wait time was calculated as the number of days between the visit prior to the day before the procedure with the physician performing the procedure and the day of the procedure.

Regression Models

Regression models were constructed to assess the changes in *procedure volumes*, *length of stays*, *wait times* and *complication rates* across the three consolidation periods for Edmonton Capital Health, the Calgary Health Region and all other RHAs. The three periods were pre-consolidation (Phase I), post-consolidation (Phase II) and post-deconsolidation (Phase III).

Changes in procedure volumes associated with the three time periods were assessed using Poisson models. Daily counts of procedures were regressed on site RHA and time period where the number of procedures was the outcome and the number of days was the denominator (offset). No adjustments were made for patient demographics as the main aim of this analysis was to explore change in service loads for program areas affected by consolidation, and therefore controlling for patient characteristics was deemed to be irrelevant in this context. Risk ratios and ninety-five percent confidence intervals for change in procedure volumes were calculated. The risk ratio provides an estimate of the comparison of daily procedure rates from one period to another. For instance, in a comparison of procedure volume from the period before consolidation to that after consolidation, a risk ratio estimate of 1.15 indicates that the daily rate of procedures increased by fifteen percent after consolidation.

Since complete physician claims data prior to January, 1994 was not available to us, Poisson regression models for procedures that could be performed on an outpatient basis were based on data after January, 1994. For procedures that were performed exclusively on inpatients, regression models were based on data after April, 1992.

Poisson regression methods were also used to examine the differences in in-hospital complications over the three periods. Adjustments were made for patient age group, sex, elective / non-elective status of procedure, anemia as a comorbidity during the episode of care, and diabetes and / or myocardial infarction within three months prior to procedure. Models were constructed with counts of procedures with major complications as the outcome and number of procedures as the denominator (offset).

Region-specific changes in length of stays for inpatient procedures across the three consolidation periods were analyzed using two different regression methods. The majority of low-intensity procedures were characterized by short episodes of less than five days, therefore the LOS measures were treated as counts of rare events and Poisson regression methods were used. High-intensity procedures, on the other hand, had normally distributed LOS measures and therefore, linear regression models were employed. Coefficient, or beta estimates derived from the linear regression models measure the actual changes in LOS as oppose to the relative changes indicated by the risk ratio estimates from the Poisson models (as mentioned above). Thus our results displayed either actual changes or relative changes, depending on which model was appropriate for the condition. A positive beta value indicates an increase in LOS between the two time periods compared and a negative value indicates a decrease in LOS. For instance, a beta estimate of -3.2 from the period before consolidation to that after consolidation means that there was a decline in LOS by 3.2 days after consolidation. We adjusted for patient age and sex to control for patient case mix.

Linear regression models were also used to analyze differences in wait times associated with consolidation and deconsolidation for the three regions. Models were constructed with wait times as the outcome with adjustments for age group and sex.

The results from the regression models may seem different from observations of the annual trends presented in the graphs primarily, because the cut points of the three consolidating periods assessed in the regression models do not correspond to the cut points of the fiscal years that the points on the graphs are based on.

RESULTS

Surgical Activity

Overall, study findings showed that in Edmonton Capital Health, the volume of most high intensity procedures increased after consolidation, while volumes of most low intensity procedures decreased. However, this trend was also observed in the other comparison RHAs. Tables 1 to 4 provide the risk ratio and coefficient estimates for certain measures of change. These risk ratios and coefficient estimates were used to determine changes between the pre-consolidation period (Phase I), the post-consolidation period (Phase II), and the post-deconsolidation period (Phase III). Where procedures were not deconsolidated, Phase II covers the entire post-deconsolidation period. Annual volumes and rates of utilization are provided in Figures 1 to 54.

Neurosurgery

Craniotomy for Tumours

The volume of craniotomies in Edmonton Capital Health increased (+15%) between Phase I and Phase II of the consolidation process. There was no significant change in volumes between Phase II and Phase III. The Calgary Health Region saw a similar increase between Phase I and II (+13%), and a large increase between Phase II and Phase III (+43%). There were no craniotomies performed in the other RHAs. Lengths of stay in Edmonton Capital Health decreased by 4.2 days between Phase I and Phase II. There were no significant changes in LOS in the Calgary Health Region between Phase I and Phase II. There were no significant changes in LOS in any RHA between Phase II and Phase III.

Figures 1 and 2 provide information on annual trends for the measures of interest.

Gynecology

Debulking for Ovarian Cancer

There was no significant change in the volume of procedures performed in Edmonton Capital Health between Phase I and Phase II. No significant change was observed in the other RHAs. In contrast, the Calgary Health Region saw a twenty-four percent increase in volume in the same period. However, overall numbers were small. There was no significant change in lengths of stay in Edmonton Capital Health between Phase I and Phase II. Similarly there was no change in LOS in the Calgary Health Region. Lengths of stay decreased in the other RHAs by 6.2 days.

Figures 3 and 4 provide information on annual trends in the measures of interest.

Tubal Ligations

The volume of procedures in Edmonton Capital Health decreased twenty-six percent between Phase I and Phase II. A decrease of ten percent and fourteen percent were observed in the Calgary Health Region and the other RHAs respectively. There was no significant change in lengths of stay in Edmonton Capital Health between Phase I and Phase II. Similarly there was no change in LOS in the Calgary Health Region. Lengths of stay decreased in the other RHAs by sixty-seven percent.

Figures 5 and 6 provide information on annual trends in the measures of interest.

Orthopedics

Total Hip and Knee Replacements

Volumes of procedures increased twenty-eight percent in Edmonton Capital Health between Phase I and Phase II. This was greater than the twelve percent increase observed in the Calgary Health Region, but less than the thirty-four percent increase observed in the other RHAs. However, total volumes increased more in Edmonton Capital Health. Lengths of stay in Edmonton Capital Health decreased by 7.8 days between Phase I and Phase II. Lengths of stay also decreased in the other RHAs, but at a smaller magnitude (2.6 days in the Calgary Health Region and 3.4 days in the other RHAs).

Figures 7 and 8 provide information on annual trends in the measures of interest.

General Surgery

Colon Resection for Cancer

There was no significant change in volumes in Edmonton Capital Health between Phase I and Phase II. There were, however, significant increases in volumes in the Calgary Health Region (+9%) and non-metro RHAs (+12%). There was a significant increase (+9%) in volumes in Edmonton Capital Health between Phase II and Phase III. A similar increase (+10%) was also observed in the other RHAs. Lengths of stay in Edmonton Capital Health fell by 1.9 days between Phase I and Phase II. Lengths of stay fell (by 2.9 days) in the other RHAs during this period. There was no significant change in LOS in the Calgary Health Region. There was no significant change in LOS in Edmonton Capital Health between Phase II and Phase III. LOS decreased by 2.6 days in the Calgary Health Region and by 2.4 days in the other RHAs during this period.

Figures 9 and 10 provide information on annual trends in the measures of interest.

Laparoscopic Cholecystectomies

There was no significant change in the volume of procedures performed in Edmonton Capital Health between Phase I and Phase II. Similarly, there was no significant change in volumes in the Calgary Health Region. However, there was an increase in the other RHAs (+8%). There was no significant change in volumes of procedures in Edmonton Capital Health between Phase II and Phase III, though there were significant increases in the Calgary Health Region and the other RHAs. Lengths of stay in Edmonton Capital Health increased eight percent between Phase I and Phase II. Lengths of stay in the Calgary Health Region

increased by fourteen percent during this period. However, lengths of stay decreased eight percent in the other RHAs. Lengths of stay in Edmonton Capital Health increased twenty-six percent days between Phase II and Phase II. There were no significant changes in LOS for the Calgary Health Region, while LOS increased three percent for the other RHAs.

Figures 11 and 12 provide information on annual trends in the measures of interest.

Urology

Nephrectomy for Tumour

There was a significant increase (+16%) in the volume of procedures performed in Edmonton Capital Health between Phase I and Phase II. An increase in volumes of twenty-nine percent was observed in the other RHAs during this period. There was no significant change observed in the Calgary Health Region during this time. Lengths of stay in Edmonton Capital Health decreased by 2.9 days between Phase I and Phase II. Similar decreases of 2.8 days and 3.6 days were observed in the Calgary Health Region and the other RHAs respectively.

Figures 13 and 14 provide information on annual trends in the measures of interest.

TURP

There was a significant decrease (-44%) in the volume of procedures performed in Edmonton Capital Health between Phase I and Phase II. There were smaller decreases observed in the Calgary Health Region (-20%) and the other RHAs (-19%). The larger decrease in Edmonton Capital Health reflects the fact that Edmonton Capital Health initially performed a greater number of TURPs than the other RHAs, and that the decrease only brought them in line with volumes in the other RHAs. Average lengths of stay in Edmonton Capital Health fell by thirty-nine percent between Phase I and Phase II. Similar decreases of twenty-seven percent and twenty-nine percent were observed in the Calgary Health Region and the other RHAs respectively.

Figures 15 and 16 provide information on annual trends in the measures of interest.

Vascular

Abdominal Aortic Aneurysm

There was no significant change in volumes in Edmonton Capital Health between Phase I and Phase II. Similarly, there were no significant changes in volumes in the other RHAs. There was a significant increase (+33%) in volumes in Edmonton Capital Health between Phase II and Phase III. A similar increase was (+42%) was observed in the Calgary Health Region during this period. There were no significant changes in LOS in Edmonton Capital Health between Phase II and Phase III. Similarly, there was no significant changes in LOS in the Calgary Health Region. However, LOS in the other RHAs decreased 10.8 days.

Figures 17 and 18 provide information on annual trends in the measures of interest.

Ligation and Stripping of the Veins

Volumes of procedures in the Edmonton Capital Health fell by sixteen percent between Phase I and Phase II. There was no significant change in the other RHAs during this time. There was no significant change in volumes for Edmonton Capital Health Phase II and Phase III. Volumes in the Calgary Health Region increased sixteen percent during this time, while there was no significant change in the other RHAs. Average lengths of stay for Edmonton Capital Health fell by fifty-one percent between Phase I and Phase II. A decrease in LOS was seen in the Calgary Health Region (-21%) and the other RHAs (-47%). There was no significant change in average lengths of stay for Edmonton Capital Health between Phase II and Phase III. However, LOS increased twenty-six percent for the Calgary Health Region and decreased eleven percent for the other RHAs during this period.

Figures 19 and 20 provide information on annual trends in the measures of interest.

Thoracic

Thoracotomy for Tumour

There was no significant change in the volume of procedures in Edmonton Capital Health between Phase I and Phase II. Similar observations were made for the other RHAs. Average lengths of stay for Edmonton Capital Health decreased by 2.1 days between Phase I and Phase II. A greater decrease (-3.3 days) was observed in the Calgary Health Region. There was no significant change in the other RHAs.

Figures 21 and 22 provide information on annual trends in the measures of interest.

Plastic Surgery

Microvascular Free Tissue Transfer

The volume of procedures performed in Edmonton Capital Health increased fifteen percent between Phase I and Phase II. Volumes in the other RHAs increased thirty-nine percent. There was no significant change in the Calgary Health Region during this period. In Edmonton Capital Health, the proportion of non-elective procedures decreased after consolidation. A similar pattern was observed in the Calgary Health Region. Lengths of stay in Edmonton Capital Health decreased two percent between Phase I and Phase II. An increase in LOS of eight percent was observed in the Calgary Health Region, while a decrease in LOS of twenty-five percent was observed in the other RHAs.

Figures 23 and 24 provide information on annual trends in the measures of interest.

Reduction Mammoplasty

The volume of procedures in Edmonton Capital Health did not change significantly between Phase I and Phase II. Volumes decreased by nine percent and increased by forty-one percent in the Calgary Health Region and the other RHAs respectively. Average lengths of stay in Edmonton Capital Health decreased seventeen percent between Phase I and Phase II. Decreases in lengths of stay of twenty-nine percent and thirty-six percent were observed in the Calgary Health Region and the other RHAs respectively during this period.

Figures 25 and 26 provide information on annual trends in the measures of interest.

ENT

Laryngectomy for Cancer

There were no significant changes in volumes of procedures between Phase I and Phase II in Edmonton Capital Health. Similarly, there were no significant changes in the Calgary Health Region or all other RHAs. There were no significant changes in average lengths of stay for any of the RHAs.

Figures 27 and 28 provide information on annual trends in the measures of interest.

Tonsillectomy / Adenoidectomy

Volumes of procedures in the Edmonton Capital Health fell by twenty-six percent between Phase I and Phase II. Decreases of forty percent and thirty-two percent were observed in the Calgary Health Region and the other RHAs respectively during this period. Lengths of stay in Edmonton Capital Health increased by one hundred and fifty-eight percent between Phase I and Phase II. Lengths of stay increased by nineteen percent in the Calgary Health Region and fell by thirty-one percent in the other RHAs during this period.

Figures 29 and 30 provide information on annual trends in the measures of interest.

Outcomes

Total Hip Replacement

The rate of major complications decreased twenty-three percent for the Edmonton Capital Health and decreased forty-four percent for the Calgary Heath Region between Phase I and Phase II. There were no significant changes in rates of complications in the other RHAs.

Figure 31 provide information on annual trends in rates of complications.

Colon Resection for Cancer

Rates of complications increased thirty percent for Edmonton Capital Health between Phase I and Phase II. There were no significant changes in the other RHAs. There were no significant changes in the rates of complications for Edmonton Capital Health between Phase II and Phase III. Similarly, there was no significant change in the other RHAs during this time.

Figure 32 provide information on annual trends in rates of complications.

Laparoscopic Cholecystectomy

Rates of complications in Edmonton Capital Health decreased by thirty percent between Phase I and Phase II. Complication rates decreased by twenty-nine percent in the other RHAs. There was no significant change in complication rates in the Calgary Health Region. There were no significant changes in complications rates in Edmonton Capital Health and the other RHAs between Phase II and Phase III. Complication rates in the Calgary Health Region fell by thirty-eight percent during this period.

Figure 33 provide information on annual trends in rates of complications.

Microvascular Free Tissue Transfer

There were no significant changes in the rates of complications for any of the RHAs between Phase I and Phase II.

Figure 34 provide information on annual trends in rates of complications.

Wait Times

Neurosurgery

Craniotomy for Tumours

There was no significant change in average waiting times in Edmonton Capital Health between Phase I and Phase II. The same was observed for the Calgary Health Region. There was an increase in wait times of 55.2 days in Edmonton Capital Health between Phase II and Phase III, though there were no significant changes in the Calgary Health Region.

Figures 35 and 36 provide information on annual trends in mean and median wait times.

Gynecology

Debulking for Ovarian Cancer

There were no significant changes in average waiting times in any of the RHAs between Phase I and Phase II.

Figures 37 and 38 provide information on annual trends in mean and median wait times.

Orthopedics

Total Hip and Knee Replacements

Average waiting times increased in Edmonton Capital Health by 10.8 days between Phase I and Phase II. Wait times in the other RHAs increased by 16.2 days during this period. The Calgary Health Region had a more dramatic increase of 37.9 days.

Figures 39 and 40 provide information on annual trends in mean and median wait times.

General Surgery

Colon Resection for Cancer

Average wait times increased in Edmonton Capital Health by 19.3 days between Phase I and Phase II. There was no significant change in wait times for the Calgary Health Region between these phases. There was no significant change in wait times for all RHAs between Phase II and Phase III.

Figures 41 and 42 provide information on annual trends in mean and median wait times.

Laparoscopic Cholecystectomy

Average wait times in Edmonton Capital Health increased 20.1 days between Phase I and Phase II. A similar increase was seen in the Calgary Health Region (+27.6 days). The other RHAs saw a smaller increase in wait times of 6.6 days. Wait times also increased between Phase II and Phase III in Edmonton Capital Health (+17.5 days). There were no significant changes in wait times for the other RHAs during this period.

Figures 43 and 44 provide information on annual trends in mean and median wait times.

Urology

Nephrectomy

There were no significant changes in average wait times in any of the RHAs between Phase I and Phase II.

Figures 45 and 46 provide information on annual trends in mean and median wait times.

TURP

Average wait times in the Edmonton Capital Health increased by 16.2 days between Phase I and Phase II. A similar increase of 12.0 days was observed in the Calgary Health Region. There was no significant change in wait times for the other RHAs.

Figures 47 and 48 provide information on annual trends in mean and median wait times.

Vascular

Abdominal Aortic Aneurysm

Average wait times in the Edmonton Capital Health increased by 38.5 days between Phase I and Phase II. There was no significant change in the other RHAs during this period. There were no significant changes in wait times in any of the RHAs between Phase II and Phase III.

Figures 49 and 50 provide information on annual trends in mean and median wait times.

Thoracic

Thoracotomy for Tumours

There were no significant differences in average wait times for the RHAs between Phase I and Phase II.

Figures 51 and 52 provide information on annual trends in mean and median wait times.

ENT

Laryngectomy for Cancer

There were no significant changes in average wait times for the RHAs between Phase I and Phase II.

Figures 53 and 54 provide information on annual trends in mean and median wait times.

DISCUSSION

Summary of Findings

Our findings showed no major changes in volumes, complication rates and waiting times in Edmonton Capital Health after consolidation that were not observed in other jurisdictions. Most of the changes observed could likely be attributed to other cost-saving measures such as the reduction in the number of hospital beds, shorter lengths of inpatient stays and shifting procedures from inpatient to outpatient settings.

In Edmonton Capital Health, most high-intensity procedures that were consolidated at the referral hospitals saw an increase in the volume of procedures after consolidation. In contrast, the volume of low-intensity procedures that were primarily (but not exclusively) consolidated at the community health centres decreased after consolidation. A decrease in surgical activity can indicate a concern around access to surgical services. Assuming that need remains the same, changes in the supply of health services may reflect an under-servicing of the needs of the community. To what effect this concern is real is beyond the scope of this study. However, it is worthwhile to note this for further investigation. Since this decrease in volumes was also observed in the comparison RHAs, it probably has little to do with consolidation, and perhaps more to do with reductions in the health budgets for RHAs or other system changes within certain specialties. Trends in the volume of total hip and total knee replacement procedures were observed to increase in Edmonton Capital Health in 1996/1997 and 1999/2000, around the time that additional funding was provided to Edmonton Capital Health.

The other measure of interest was changes in adverse outcomes of care, specifically complications, for four of the index procedures. With the exception of one procedure, colon resections, complications rates in Edmonton Capital Health fell or stayed the same after consolidation. The reasons for the increase in complications of colon resection are open to speculation. One factor could be the model of service delivery, in which general surgeons found themselves working at two geographically disparate sites. This caused problems with continuity of care due to time constraints and surgeons being spread out across the region.

The final measure of interest was changes in waiting times. Generally, waiting times either increased or stayed the same after consolidation. Longer waiting times again point to concerns about access to health services. Since wait times also increased in the other RHAs, it is safe to assume that it was not consolidation that resulted in the increase in waiting times, but other factors associated with reform that were common to all the RHAs.

A few procedures stood out in terms of their change after consolidation. One such procedure was TURPs. The volume of procedures decreased in all RHAs, but more dramatically in Edmonton Capital Health. However, Edmonton Capital Health was doing more of these procedures prior to consolidation and the reduction brought them in line with the other RHAs.

The second procedure was colon resection for cancer. This procedure, part of the General Surgery program, was consolidated at the referral hospitals. Volumes of this procedure did not change after consolidation, while volumes increased in the other RHAs. However, Edmonton Capital Health did perform more procedures at the beginning of the study period and continued to perform more procedures than the other RHAs. Where changes were notable were in the rates of complications, which increased thirty percent after consolidation at the same time that rates of complications remained unchanged in the other RHAs, and in the change in wait times, which increased 19.3 days, while wait times remained unchanged in the other RHAs. A major factor in this increase could have been the decrease in the number of general surgeons working in the region. Shortly after regionalization, there were a number of early retirements amongst the general surgeons, with a decline in full-time equivalents of about thirty percent. Additionally, bed numbers in the referral hospital system decreased significantly, leading to problems in access for high acuity, inpatient elective general surgery.

The third procedure was ligation and stripping of the veins. Volumes decreased in Edmonton Capital Health not in other regions. There are also two possible explanations for this decrease. The first was that general surgeons were performing this procedure due to a shortage of vascular surgeons. Thus, the changes in general surgery around this time would have contributed to this decrease. In addition, around the time of consolidation, a new vein clinic was developed at the city which substituted ligation and stripping with injection sclerotherapy. Changes in volumes for injection sclerotherapy were not measured in this study.

The final procedure was abdominal aortic aneurysms. Wait times for this procedure increased dramatically (38.5 days) after consolidation, but did not change in the other RHAs. However, the number of procedures in the other RHAs was small, which may have contributed to the change in these RHAs not being significant.

Based on the measures explored, the findings of the study suggest that changes in utilization and outcomes in Edmonton Capital Health following consolidation were similar to changes observed in other regions. Our review of the literature on the consolidation of surgical services has found articles related primarily with the consolidation of certain surgical procedures and the volume-outcome relationship [5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22]. The majority of these articles have generally supported

the notion of the regionalization of surgical procedures based on favorable outcomes associated with higher volumes of procedures, though not invariably [23].

Validity of Findings

This study is a retrospective analysis using existing data and is economical and timely. We have used explicit definitions and analytic methods and therefore other investigators can undertake comparable analyses. However, care should be taken in placing too much credence in the information presented. These analyses are based on administrative databases with the investigators having no control over data collection and data quality. In addition to the generic limitations of using administrative databases for research purposes, particular problems are present. First, the accuracy of the information on acute hospital utilization is compromised by the difficulty, especially in some rural hospitals, of distinguishing long-term care patients from acute care patients where both kinds of patients are housed in the same facility. We have attempted to minimize the impact of this by truncating the length of stays at 365 days. Second, in urban areas in recent years, because of the shortage of acute care hospital beds, stable acute care patients have been accommodated in non-acute care settings (e.g. sub-acute units in continuing care facilities). The absence of comprehensive province-wide data on these non-acute setting stays may impact our assessment of lengths of stay. Third, our physician claims data is less discriminating in their definition of procedures. We have attempted to broader our definitions of some procedures in order to accommodate this limitation, though it is conceivable that some procedures have been missed. We have also attempted to overcome some of the shortcomings of the claims data in identifying the location (inpatient versus outpatient) of procedures by cross-linking to the inpatient data to remove cases that matched. These matches were usually in the range of eighty percent or better; therefore, the misallocation of procedures to a certain setting is probable. Finally, the evaluation of changes in the post-deconsolidation period need to be interpreted with caution as only four to sixteen months of data was available to assess changes in this period.

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FIGURE LEGEND

Table 1 – Risk Ratio estimates and ninety-five percent confidence intervals for volumes of procedures †

		Edmonton Capital Health		Calgary Health Region		Other RHAs	
		Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)
Craniotomy for Tumours	RR	1.15 *	1.19	1.13 *	1.43 *	-	-
	95% CI	(1.03, 1.28)	(0.95, 1.49)	(1.00, 1.28)	(1.15, 1.79)		
	n_1	151	173	133	151	0	1
	n_2	173	207	151	216	1	0
Debulking for Ovarian Cancer	RR	0.88	n.a.	1.24 *	n.a.	0.81	n.a.
	95% CI	(0.75, 1.05)		(1.04, 1.47)		(0.61 1.08)	
	n_1	74		60		26	
	n_2	65		74		21	
Tubal Ligations	RR	0.74 *	n.a.	0.90 *	n.a.	0.86 *	n.a.
	95% CI	(0.71, 0.77)		(0.86, 0.94)		(0.83, 0.89)	
	n_1	2,437		1,904		2,439	
	n_2	1,812		1,714		2,094	
Total Knee / Hip Replacement	RR	1.28 *	n.a.	1.12 *	n.a.	1.34 *	n.a.
	95% CI	(1.24, 1.34)		(1.07, 1.17)		(1.27, 1.40)	
	n_1	1,153		848		673	
	n_2	1,482		951		899	
Colon Resection for Cancer	RR	1.05	1.09 *	1.09 *	1.01	1.12 *	1.10 *
	95% CI	(0.99, 1.10)	(1.02, 1.16)	(1.03, 1.15)	(0.94, 1.08)	(1.04, 1.21)	(1.01, 1.20)
	n_1	875	916	718	784	422	473
	n_2	916	997	784	789	473	520
Laparoscopic Cholecystectomy	RR	0.97	1.00	1.02	1.08 *	1.03	1.14 *
	95% CI	(0.93, 1.01)	(0.96, 1.04)	(0.98, 1.06)	(1.03, 1.13)	(0.99, 1.07)	(1.10, 1.19)
	n_1	2,314	2,238	1,967	2,004	2,452	2,529
	n_2	2,238	2,235	2,004	2,165	2,529	2,890
Nephrectomy for Tumours	RR	1.16 *	n.a.	1.08	n.a.	1.29 *	n.a.
	95% CI	(1.01, 1.33)		(0.91, 1.27)		(1.00, 1.65)	
	n_1	97		70		29	
	n_2	112		75		38	
TURP	RR	0.56 *	n.a.	0.80 *	n.a.	0.81 *	n.a.
	95% CI	(0.53, 0.59)		(0.70, 0.91)		(0.75, 0.87)	
	n_1	1,264		727		546	
	n_2	704		581		1,736	

		Edmonton Capital Health		Calgary Health Region		Other RHAs	
		Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)
Abdominal Aortic Aneurysm	**RR**	**1.00**	**1.33 ***	**1.02**	**1.42 ***	**1.17**	**0.84**
	95% CI	**(0.89, 1.12)**	**(1.16, 1.52)**	**(0.88, 1.17)**	**(1.21, 1.67)**	**(0.88, 1.54)**	**(0.59, 1.22)**
	n_1	**184**	**184**	**119**	**121**	**28**	**33**
	n_2	**184**	**244**	**121**	**172**	**33**	**28**
Ligation and Stripping of Sapheneous Vein	RR	0.84 *	0.94	0.95	1.16 *	1.04	1.07
	95% CI	(0.78, 0.91)	(0.86, 1.02)	(0.88, 1.02)	(1.08, 1.25)	(0.95, 1.13)	(0.98, 1.16)
	n_1	676	567	689	655	506	525
	n_2	567	531	655	760	525	560
Thoracotomy for Tumours	**RR**	**1.04**	**n.a.**	**1.05**	**n.a.**	**1.05**	**n.a.**
	95% CI	**(0.95, 1.13)**		**(0.93, 1.20)**		**(0.75, 1.47)**	
	n_1	**271**		**122**		**17**	
	n_2	**281**		**128**		**18**	
Microvascular free tissue transfer	RR	1.15 *	n.a.	1.00	n.a.	1.39 *	n.a.
	95% CI	(1.09, 1.20)		(0.96, 1.06)		(1.29, 1.50)	
	n_1	1,485		1,367		614	
	n_2	1,701		1,373		854	
Reduction Mammoplasty	**RR**	**1.05**	**n.a.**	**0.91 ***	**n.a.**	**1.41 ***	**n.a.**
	95% CI	**(0.99, 1.10)**		**(0.85, 0.97)**		**(1.31, 1.52)**	
	n_1	**1,322**		**774**		**571**	
	n_2	**1,382**		**702**		**806**	
Laryngectomy for Cancer	RR	1.03	n.a.	1.28	n.a.	1.20	n.a.
	95% CI	(0.75, 1.42)		(0.77, 2.12)		(0.44, 3.25)	
	n_1	19		7		2	
	n_2	20		9		2	
Tonsillectomy / Adenoidecotmy	**RR**	**0.74 ***	**n.a.**	**0.60 ***	**n.a.**	**0.68 ***	**n.a.**
	95% CI	**(0.71, 0.78)**		**(0.57, 0.62)**		**(0.66, 0.70)**	
	n_1	**1,710**		**2,240**		**3,038**	
	n_2	**1,266**		**1,334**		**2,064**	

* $p < 0.050$
\- Invalid coefficient
n.a. not applicable
† Phase I denotes period prior to consolidation, Phase II denotes period between consolidation and deconsolidation and, Phase III denotes period after deconsolidation
n_1 Annual number of procedures in reference Phase
n_2 Annual number of procedures in comparison Phase

Table 2a – Coefficient estimates [1] and ninety-five percent confidence intervals for LOS [2]

		Edmonton Capital Health		Calgary Health Region		Other RHAs	
		Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)
Craniotomy for Tumours	**B**	**-4.17 ***	**-3.78**	**-1.49**	**-3.40**		
	95% CI	**(-7.15, -1.19)**	**(-9.87, 2.30)**	**(-4.05, 1.08)**	**(-8.19, 1.39)**		
	n_1	**151**	**173**	**133**	**151**		
	n_2	**173**	**204**	**151**	**216**		
Debulking for Ovarian Cancer	B	-1.18	n.a.	1.25	n.a.	-6.24 *	n.a.
	95% CI	(-3.02, 0.67)		(-0.80, 3.29)		(-11.52, -0.97)	
	n_1	74		60		26	
	n_2	65		74		21	
Total Knee / Hip Replacement	**B**	**-7.75 ***	**n.a.**	**-2.57 ***	**n.a.**	**-3.42 ***	**n.a.**
	95% CI	**(-8.40, -7.11)**		**(-3.09, -2.05)**		**(-4.15, -2.69)**	
	n_1	**1,151**		**848**		**673**	
	n_2	**1,481**		**951**		**890**	
Colon Resection for Cancer	B	-1.90 *	0.40	-1.24	-2.59 *	-2.94 *	-2.38 *
	95% CI	(-3.29, -0.51)	(-1.32, 2.13)	(-2.55, 0.07)	(-4.25, -0.92)	(-4.49, -1.38)	(-4.30, -0.47)
	n_1	873	915	717	784	422	473
	n_2	915	995	784	789	473	515
Nephrectomy for Tumours	**B**	**-2.90 ***	**n.a.**	**-2.83 ***	**n.a.**	**-3.56 ***	**n.a.**
	95% CI	**(-4.83, -0.96)**		**(-5.27, -0.38)**		**(-6.24, -0.88)**	
	n_1	**97**		**70**		**29**	
	n_2	**112**		**75**		**38**	
Abdominal Aortic Aneurysm	B	-1.41	3.29	-0.49	-0.88	-4.24	-10.82 *
	95% CI	(-3.89, 1.07)	(0.37, 6.21)	(-3.33, 2.35)	(-4.13, 2.38)	(-11.40, 2.92)	(-20.50, -1.13)
	n_1	184	184	119	121	28	33
	n_2	184	244	121	172	33	28
Thoracotomy for Tumours	**B**	**-2.06 ***	**n.a.**	**-3.34 ***	**n.a.**	**3.75**	**n.a.**
	95% CI	**(-3.22, -0.89)**		**(-5.05, -1.64)**		**(-0.34, 7.83)**	
	n_1	**271**		**122**		**17**	
	n_2	**280**		**128**		**18**	
Laryngectomy for Cancer	B	1.92	n.a.	0.97	n.a.	-1.58	n.a.
	95% CI	(-2.81, 6.64)		(-15.58, 17.52)		(-7.63, 4.46)	
	n_1	19		7		2	
	n_2	20		9		2	

1 Note: The unit for the beta estimates is number of days
2 Note: Adjusted for age-group and sex
* $p < 0.050$
\- Invalid coefficient
n.a. not applicable
† Phase I denotes period prior to consolidation, Phase II denotes period between consolidation and deconsolidation and, Phase III denotes period after deconsolidation
n_1 Number of episodes in reference Phase
n_2 Number of episodes in comparison Phase

Table 2b – Risk Ratio estimates [1] and ninety-five percent confidence intervals for LOS [2]

		Edmonton Capital Health		Calgary Health Region		Other RHAs	
		Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)
Tubal Ligations	**RR**	**0.88**	**n.a.**	**1.17**	**n.a.**	**0.67 ***	**n.a.**
	95% CI	**(0.71, 1.09)**		**(0.92, 1.49)**		**(0.61, 0.73)**	
	n_1	**75**		**39**		**308**	
	n_2	**15**		**11**		**83**	
Laparoscopic Cholecystectomy	RR	1.08 *	1.26 *	1.14 *	1.03	0.92 *	1.03 *
	95% CI	(1.05, 1.10)	(1.22, 1.30)	(1.11, 1.17)	(1.00, 1.06)	(0.91, 0.94)	(1.01, 1.06)
	n_1	1793	1293	1686	1001	1734	1992
	n_2	1293	968	1001	891	1992	2301
TURP	**RR**	**0.61 ***	**n.a.**	**0.73 ***	**n.a.**	**0.71 ***	**n.a.**
	95% CI	**(0.60, 0.62)**		**(0.71, 0.74)**		**(0.69, 0.72)**	
	n_1	**1194**		**606**		**571**	
	n_2	**620**		**497**		**391**	
Ligation and Stripping of Sapheneous Vein	RR	0.49 *	0.85	0.79 *	1.26 *	0.53 *	0.89 *
	95% CI	(0.42, 0.56)	(0.65, 1.10)	(0.65, 0.98)	(1.02, 1.55)	(0.50, 0.57)	(0.81, 0.99)
	n_1	172	57	107	24	311	272
	n_2	57	49	24	9	272	309
Microvascular free tissue transfer	**RR**	**0.98 ***	**n.a.**	**1.08 ***	**n.a.**	**0.75 ***	**n.a.**
	95% CI	**(0.96, 0.99)**		**(1.05, 1.11)**		**(0.72, 0.79)**	
	n_1	**278**		**120**		**68**	
	n_2	**235**		**132**		**61**	
Reduction Mammoplasty	RR	0.83 *	n.a.	0.71 *	n.a.	0.64 *	n.a.
	95% CI	(0.78, 0.88)		(0.67, 0.76)		(0.60, 0.68)	
	n_1	457		307		217	
	n_2	367		273		307	
Tonsillectomy/ Adenoidecotmy	**RR**	**2.56 ***	**n.a.**	**1.19 ***	**n.a.**	**0.69 ***	**n.a.**
	95% CI	**(2.34, 2.84)**		**(1.12, 1.26)**		**(0.67, 0.71)**	
	n_1	**383**		**1301**		**2141**	
	n_2	**28**		**223**		**1168**	

1 Note: Adjusted for age-group and sex
* $p < 0.050$
\- Invalid coefficient
n.a. not applicable
† Phase I denotes period prior to consolidation, Phase II denotes period between consolidation and deconsolidation and, Phase III denotes period after deconsolidation
n_1 Number of episodes in reference Phase
n_2 Number of episodes in comparison Phase

Table 3 – Risk Ratio estimates and ninety-five percent confidence intervals for rates of major in-hospital complications [1]

		Edmonton Capital Health		Calgary Health Region		Other RHAs	
		Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)
Total Hip Replacement	RR	0.77 *	n.a.	0.56 *	n.a.	0.78	n.a.
	95% CI	(0.60, 0.97)		(0.44, 0.72)		(0.55, 1.11)	
	n_1	37		42		16	
	n_2	32		24		15	
Colon Resection for Cancer	RR	1.30 *	0.89	1.11	0.89	1.00	1.03
	95% CI	(1.09, 1.56)	(0.71, 1.12)	(0.88, 1.40)	(0.65, 1.21)	(0.69, 1.45)	(0.66, 1.61)
	n_1	62	83	39	46	17	18
	n_2	83	87	46	40	18	20
Laparoscopic Cholecystectomy	RR	0.70 *	1.22	1.16	0.62 *	0.71*	1.09
	95% CI	(0.58, 0.85)	(0.93, 1.62)	(0.98, 1.38)	(0.46, 0.83)	(0.56, 0.89)	(0.82, 1.45)
	n_1	92	51	96	70	50	42
	n_2	51	52	70	39	42	52
Microvascular Free Tissue Transfer	RR	0.93	n.a.	1.00	n.a.	-	n.a.
	95% CI	(0.72, 1.20)		(0.67, 1.51)		-	
	n_1	34		12		3	
	n_2	27		14		1	

1 Note: Adjusted for age-group, sex, elective/non-elective status, anemia, myocardial infarction and diabetes

* $p < 0.050$

n.a. not applicable

† Phase I denotes period prior to consolidation, Phase II denotes period between consolidation and deconsolidation and, Phase III denotes period after deconsolidation

n_1 Annual number of major in-hospital complications in reference Phase

n_2 Annual number of major in-hospital complications in comparison Phase

Table 4 – Coefficient estimates [1] and ninety-five percent confidence intervals for wait times by site RHA and time period, Alberta [2]

		Edmonton Capital Health		Calgary Health Region		Other RHAs	
		Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)
Craniotomy for Tumours	**B**	**19.22**	**55.16 ***	**-0.12**	**25.48**	-	-
	95% CI	**(-2.70, 41.14)**	**(11.41, 98.91)**	**(-34.29, 34.05)**	**(-32.86, 83.82)**		
	n_1	**90**	**160**	**33**	**88**	**0**	**0**
	n_2	**160**	**16**	**88**	**9**	**0**	**0**
Total Knee/Hip Replacement	B	10.83*	n.a.	37.91 *	n.a.	16.16 *	n.a.
	95% CI	(4.56, 17.09)		(30.72, 45.10)		(7.91, 24.40)	
	n_1	1,098		889		637	
	n_2	4,650		2,801		2,644	
Colon Resection for Cancer	**B**	**19.26 ***	**8.66**	**8.20**	**0.11**	**8.25**	**-0.81**
	95% CI	**(5.45, 33.07)**	**(-3.87, 21.19)**	**(-6.81, 25.21)**	**(-17.75, 17.98)**	**(-9.52, 26.03)**	**(-16.38, 14.76)**
	n_1	**282**	**646**	**194**	**387**	**157**	**480**
	n_2	**646**	**377**	**387**	**168**	**480**	**227**
Laparoscopic Cholecystectomy	B	20.05 *	17.49 *	27.60 *	-3.35	6.55 *	2.94
	95% CI	(14.40, 25.70)	(10.24, 24.74)	(21.22, 33.99)	(-15.36, 8.66)	(1.98, 11.12)	(-1.44, 7.32)
	n_1	995	2,130	1,139	1,000	1,490	3,417
	n_2	2,130	511	1,000	278	3,417	1,687
Nephrectomy for Tumours	**B**	**5.51**	**n.a.**	**9.17**	**n.a.**	**-3.50**	**n.a.**
	95% CI	**(-6.41, 17.43)**		**(-5.53, 23.88)**		**(-27.72, 20.72)**	
	n_1	**71**		**47**		**17**	
	n_2	**363**		**233**		**95**	
TURP	B	16.16 *	n.a.	11.96 *	n.a.	6.32	n.a.
	95% CI	(10.08, 21.52)		(3.36, 20.57)		(-2.60, 15.25)	
	n_1	971		322		305	
	n_2	2,214		1,386		1,185	
Abdominal Aortic Aneurysm	**B**	**38.46 ***	**-9.96**	**10.56**	**7.86**	**9.89**	**6.15**
	95% CI	**(18.57, 58.34)**	**(-27.07, 7.16)**	**(-22.72, 43.84)**	**(-24.48, 40.21)**	**(-34.21, 53.98)**	**(-37.85, 50.15)**
	n_1	**118**	**306**	**48**	**166**	**24**	**63**
	n_2	**306**	**185**	**166**	**107**	**63**	**24**
Thoracotomy for Tumours	B	1.28	n.a.	2.52	n.a.	15.80	n.a.
	95% CI	(-3.10, 5.66)		(-15.97, 21.01)		(-9.94, 41.55)	
	n_1	177		14		5	
	n_2	745		19		24	

		Edmonton Capital Health		Calgary Health Region		Other RHAs	
		Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)	Phase II † (ref: Phase I)	Phase III † (ref: Phase II)
Debulking for Ovarian Cancer	B	42.68	n.a.	9.90	n.a.	55.77	n.a.
	95% CI	(-11.07, 96.44)		(-90.83, 110.63)		(-4.36, 154.90)	
	n_1	39		11		11	
	n_2	111		33		37	
Laryngectomy for Cancer	B	-4.87	n.a.	7.57	n.a.	-0.31	n.a.
	95% CI	(-11.79, 2.23)		(-9.38, 24.52)		(-25.28, 24.67)	
	n_1	13		2		1	
	n_2	61		25		6	

1 Note: The unit for the coefficient estimates is number of days
2 Note: Adjusted for age-group and sex
* $p < 0.050$
\- Invalid coefficient
n.a. not applicable
† Phase I denotes period prior to consolidation, Phase II denotes period between consolidation and deconsolidation and, Phase III denotes period after deconsolidation
n_1 Number of procedures in reference Phase that analysis was based on
n_2 Number of procedures in comparison Phase that analysis was based on

Figure 1 – Surgical Activity for Craniotomies for Tumours

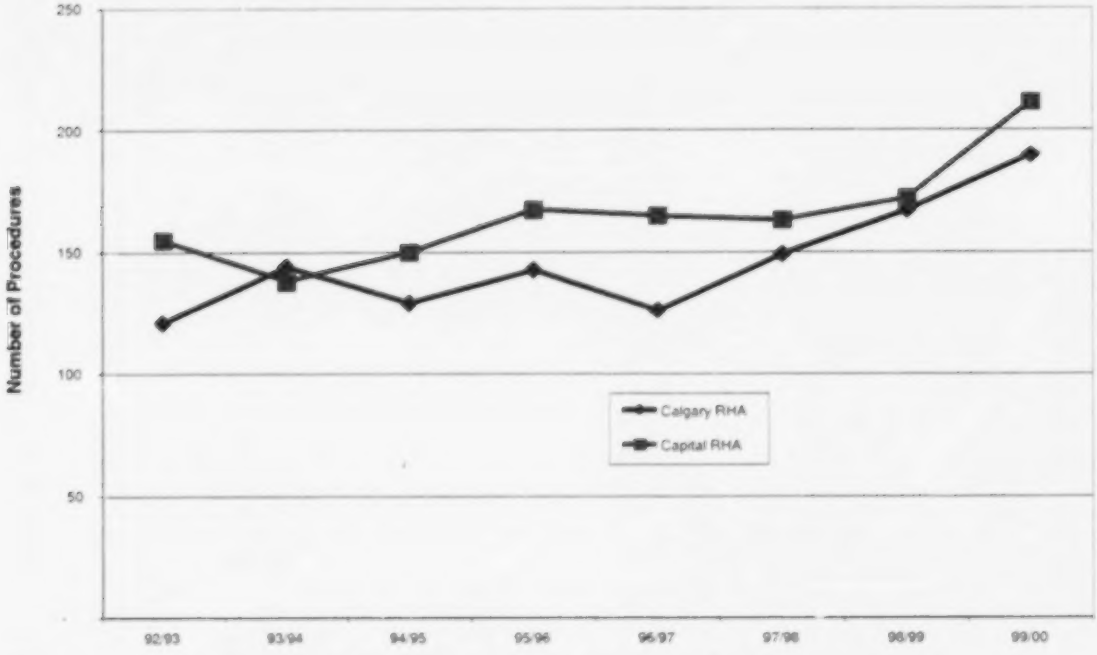


Figure 2 – Average Inpatient LOS for Craniotomies for Tumours

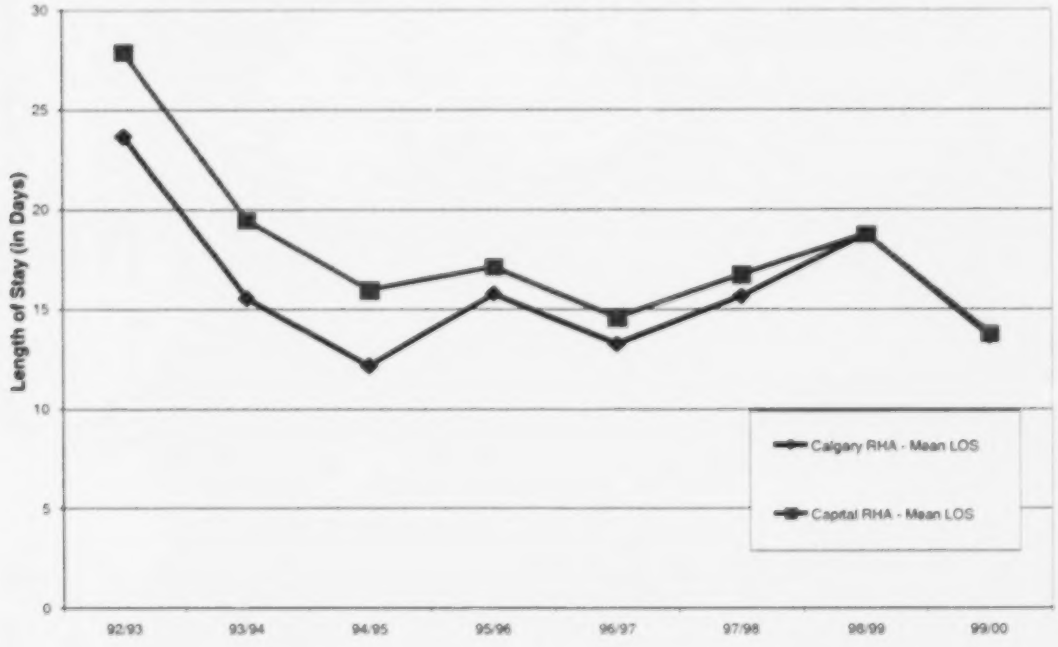


Figure 3 – Surgical Activity for Debulking for Ovarian Cancer

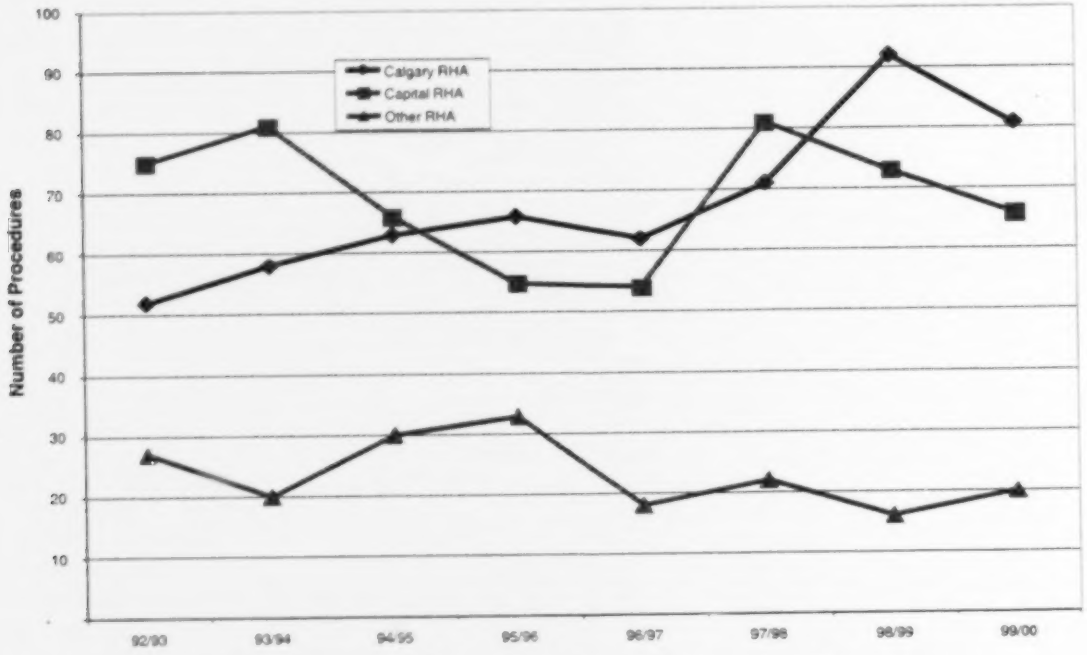


Figure 4 – Average Inpatient LOS for Debulking for Ovarian Cancer

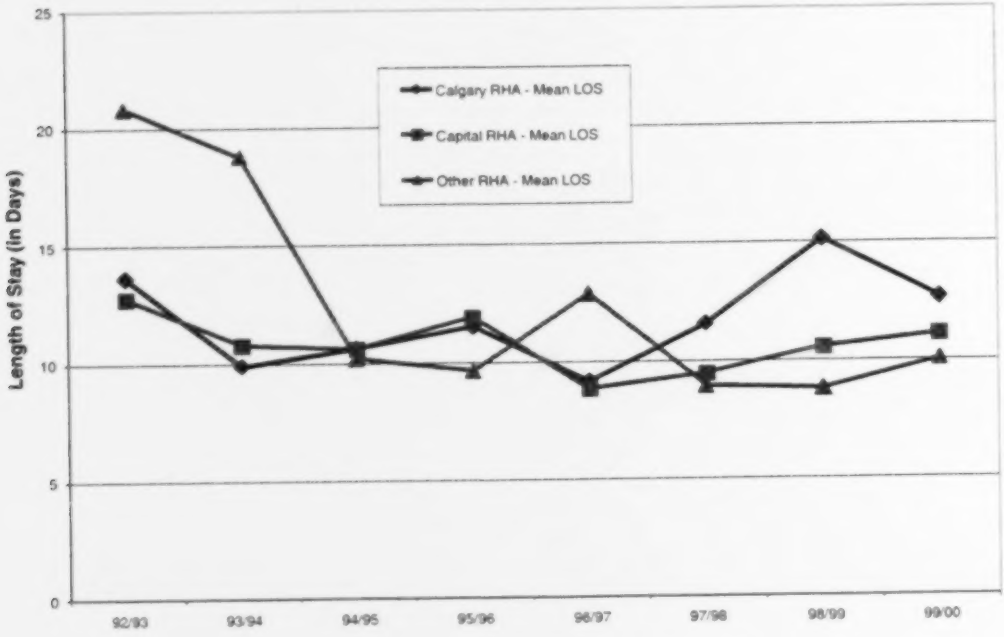


Figure 5 – Surgical Activity for Tubal Ligations

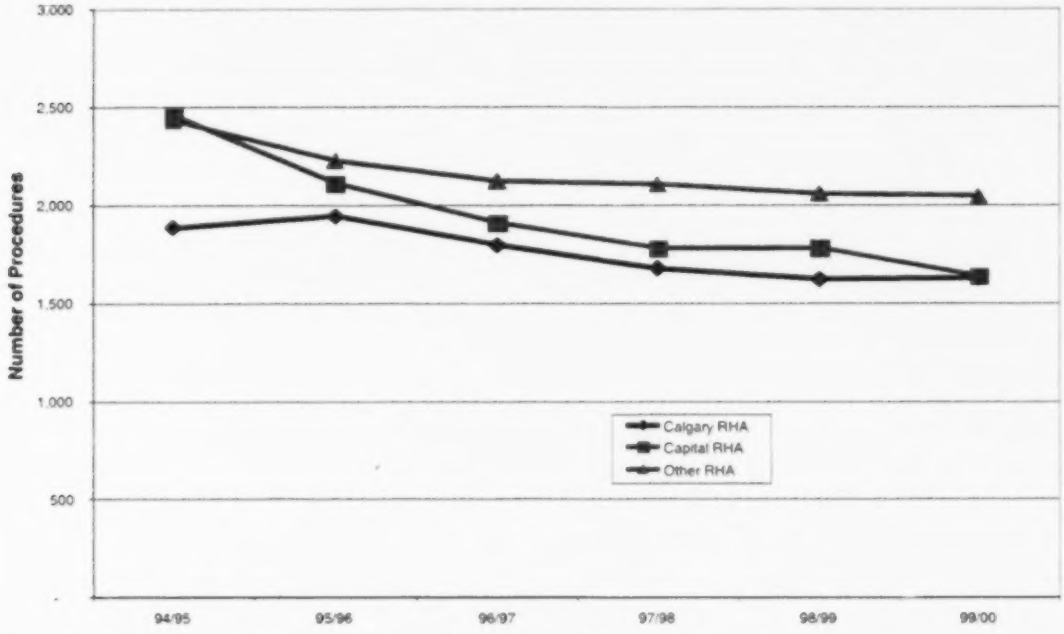


Figure 6 – Average Inpatient LOS for Tubal Ligations

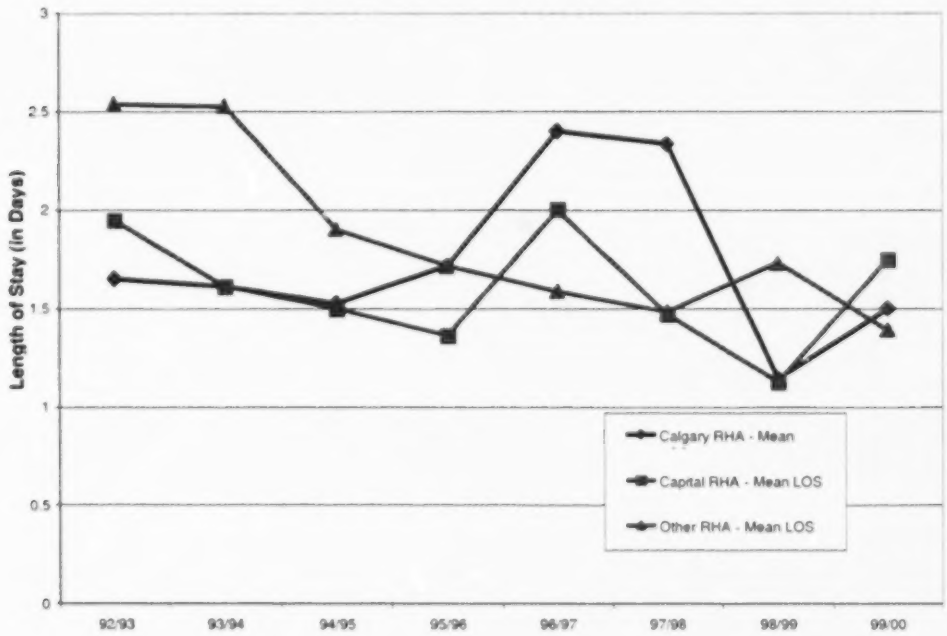


Figure 7 – Surgical Activity for Total Hip and Knee Replacements

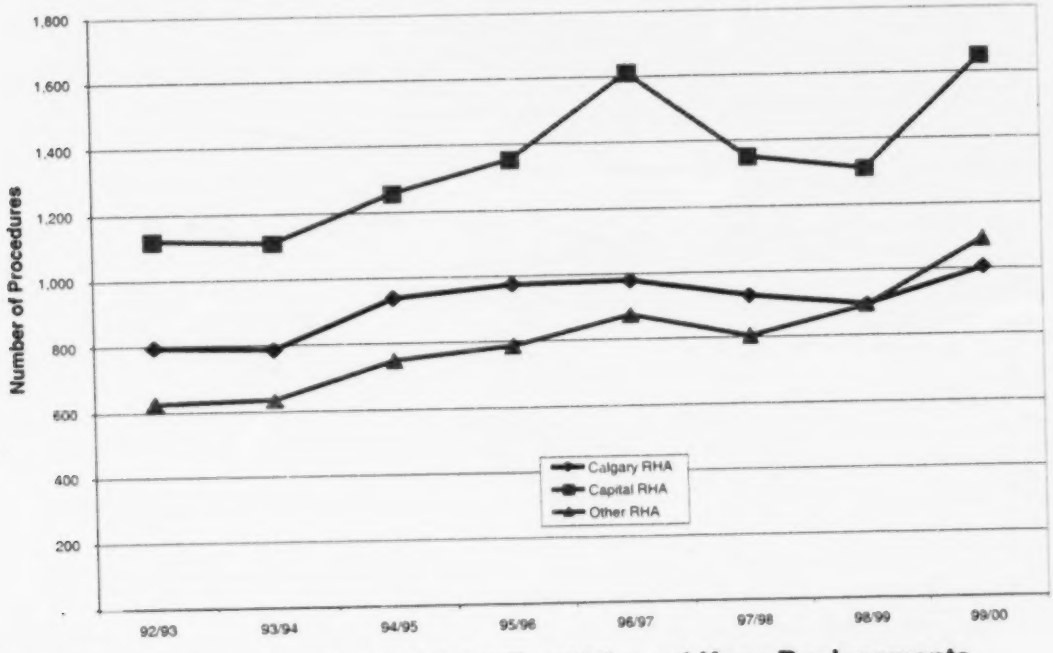


Figure 8 – Average Inpatient LOS for Total Hip and Knee Replacements

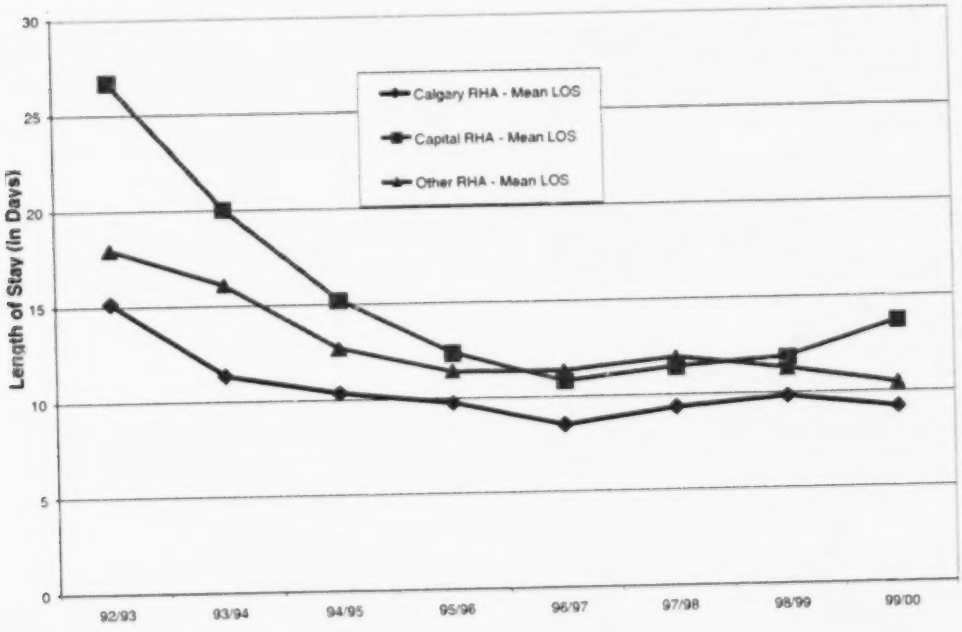


Figure 9 – Surgical Activity for Colon Resections for Cancer

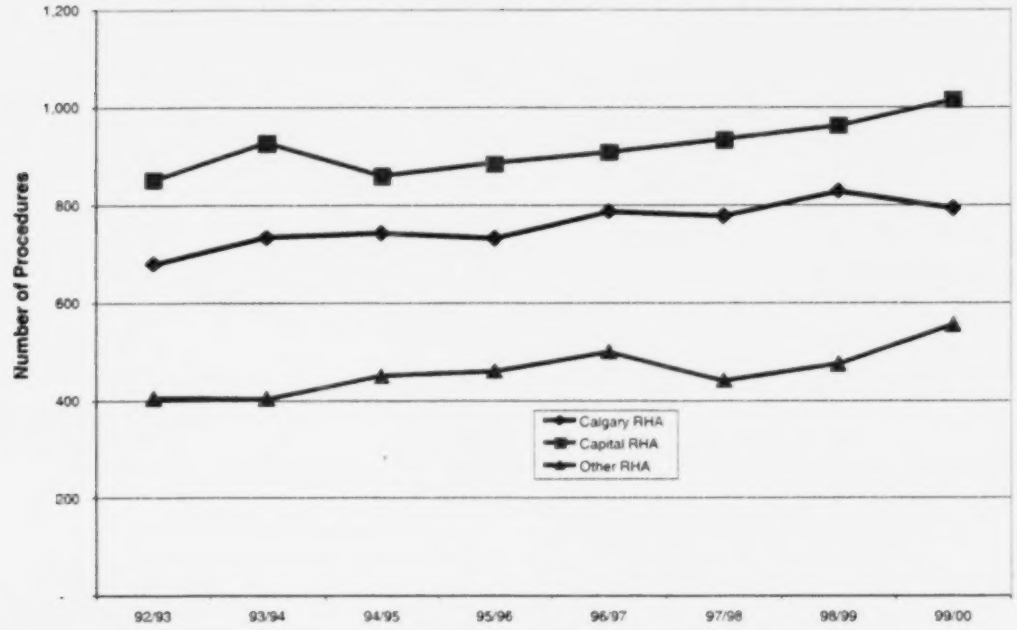


Figure 10 – Average Inpatient LOS for Colon Resections for Cancer

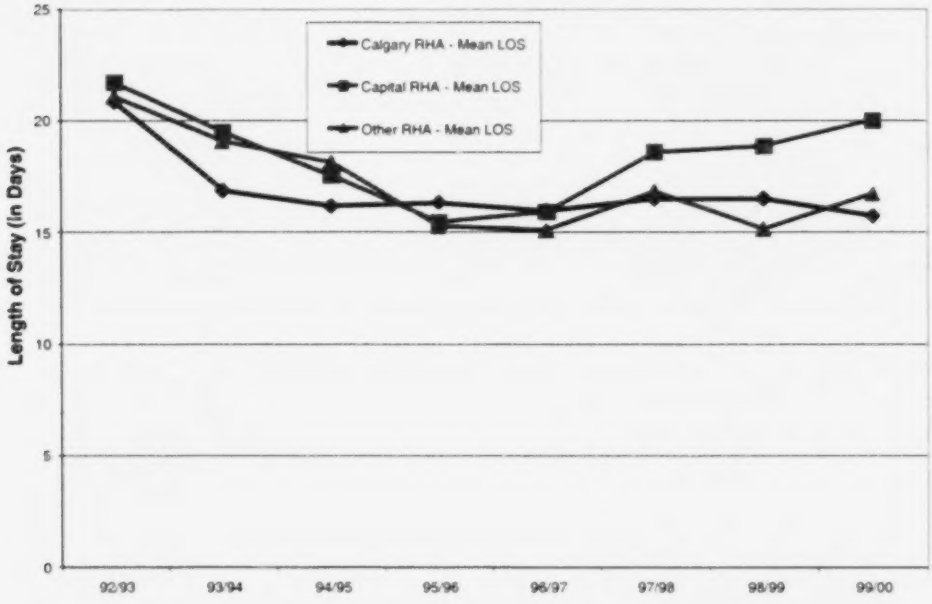


Figure 11 – Surgical Activity for Laparoscopic Cholecystectomies

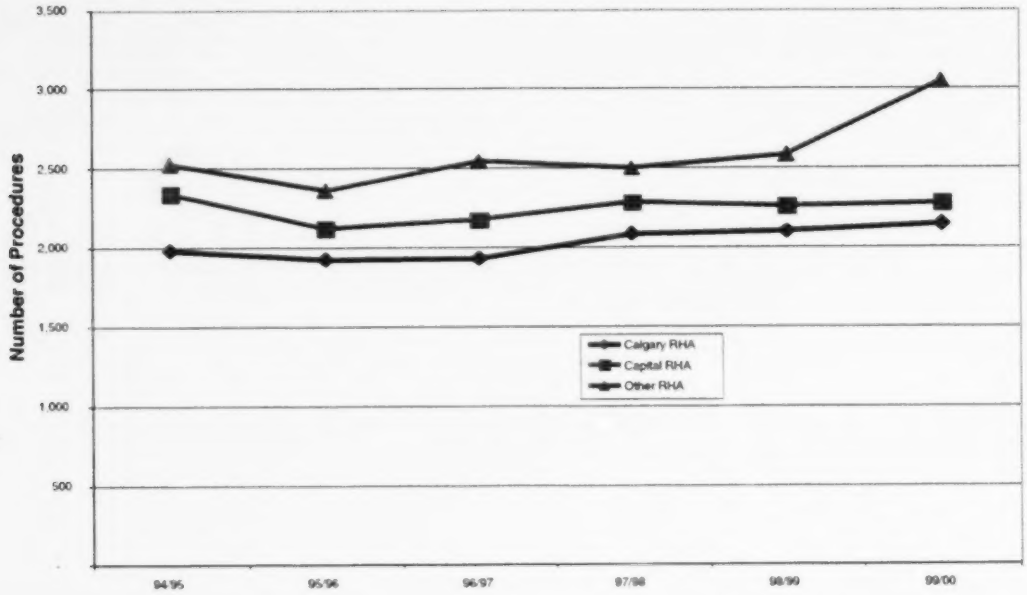


Figure 12 – Average Inpatient LOS for Laparoscopic Cholecystectomies

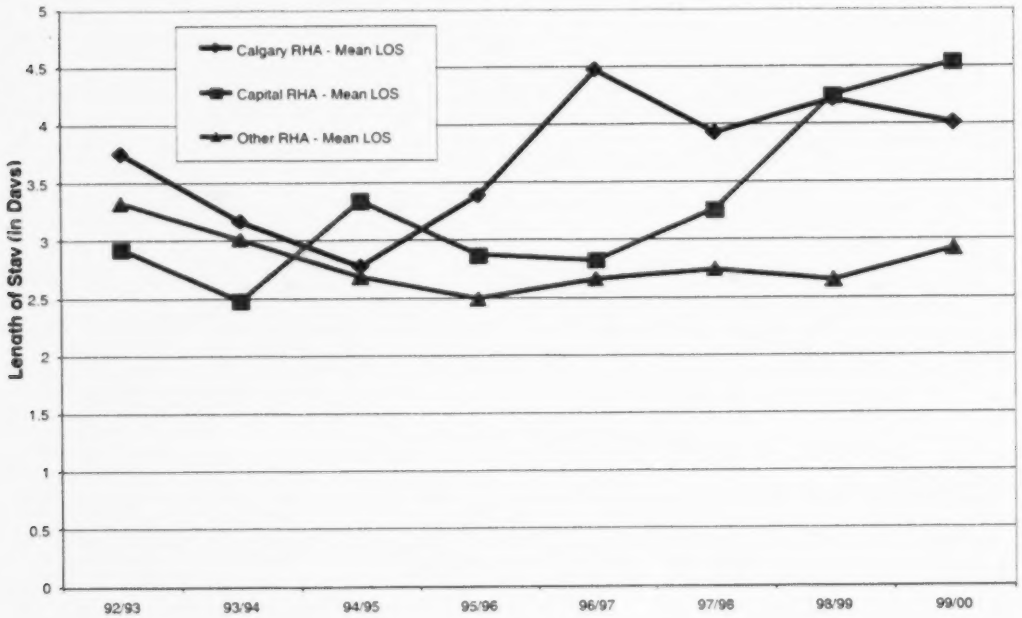


Figure 13 – Surgical Activity for Nephrectomies for Tumours

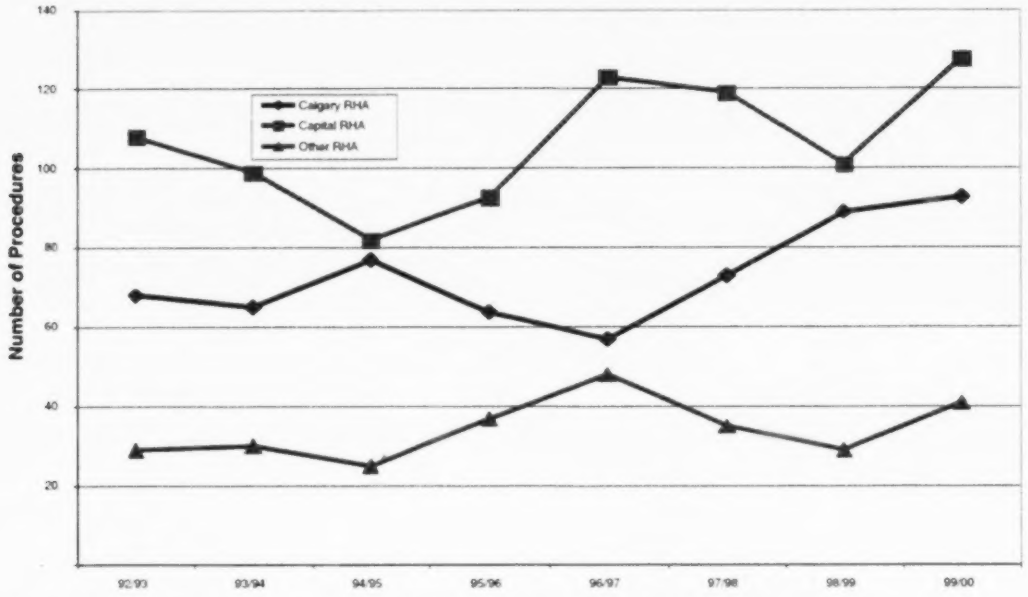


Figure 14 – Average Inpatient LOS for Nephrectomies for Tumours

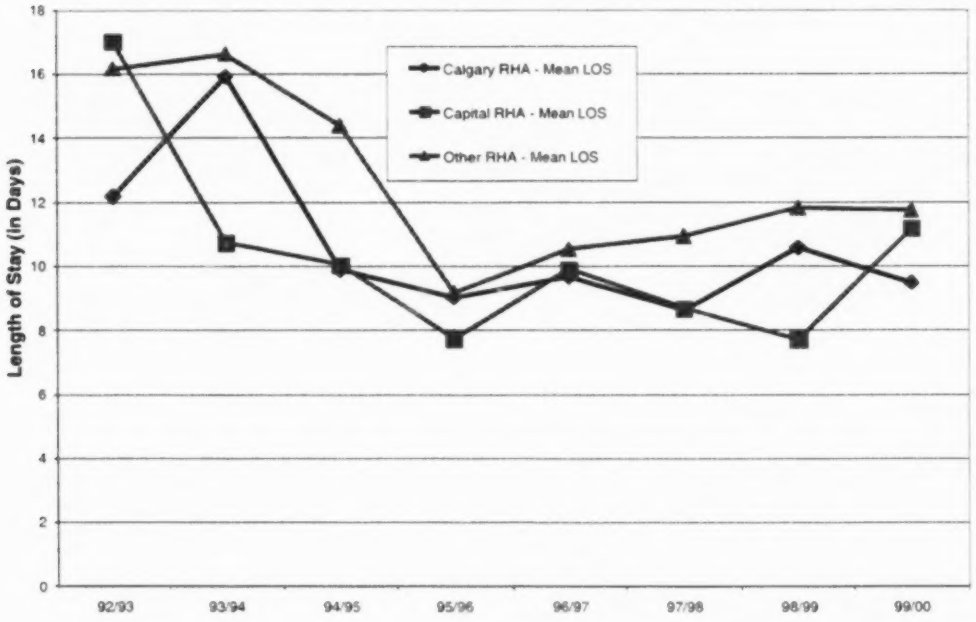


Figure 15 – Surgical Activity for TURPs

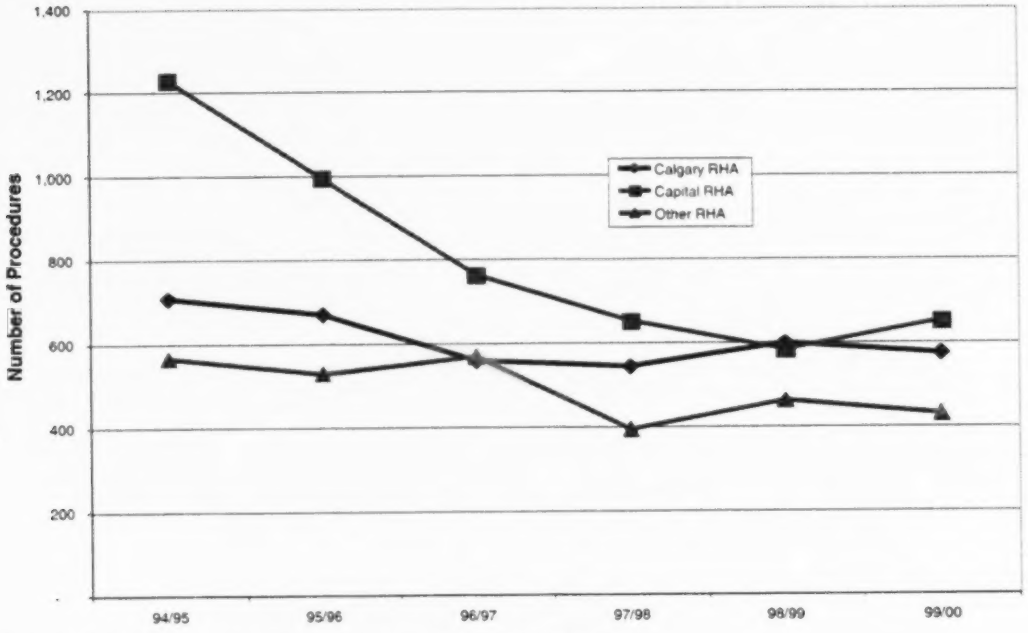


Figure 16 – Average Inpatient LOS for TURPs

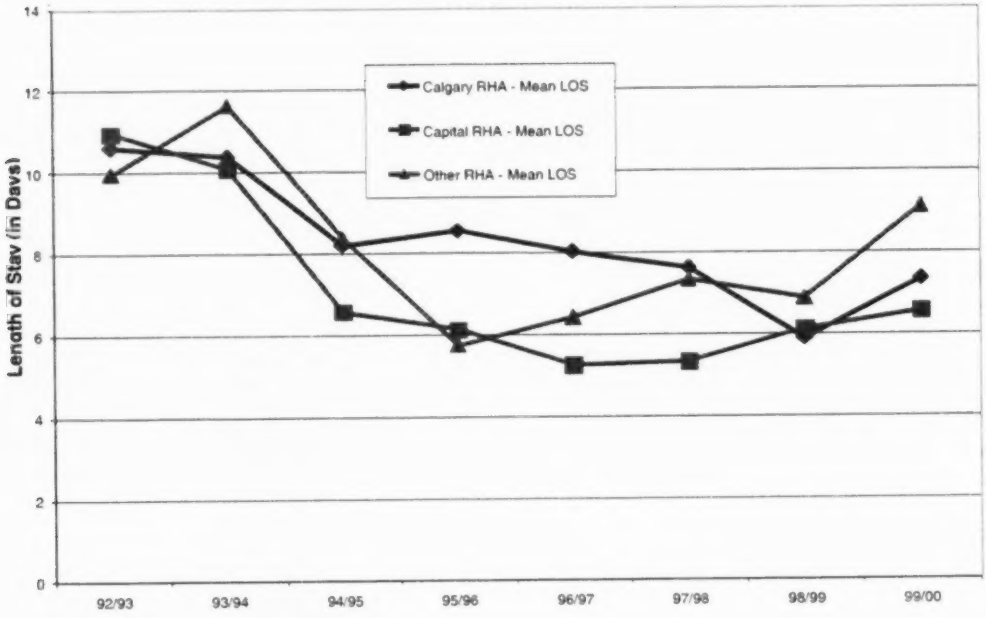


Figure 17 – Surgical Activity for Abdominal Aortic Aneurysms

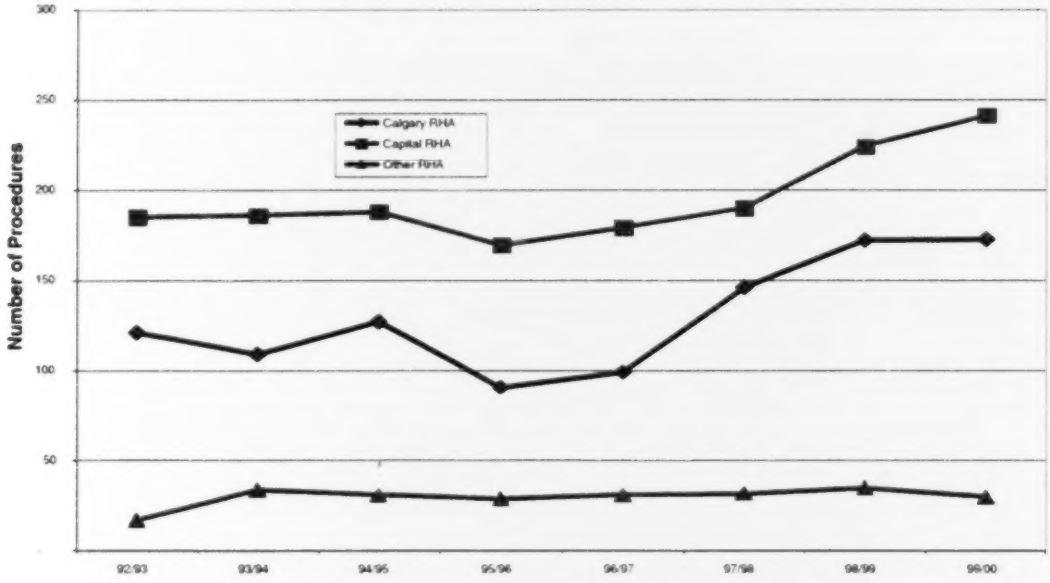


Figure 18 – Average Inpatient LOS for Abdominal Aortic Aneurysms

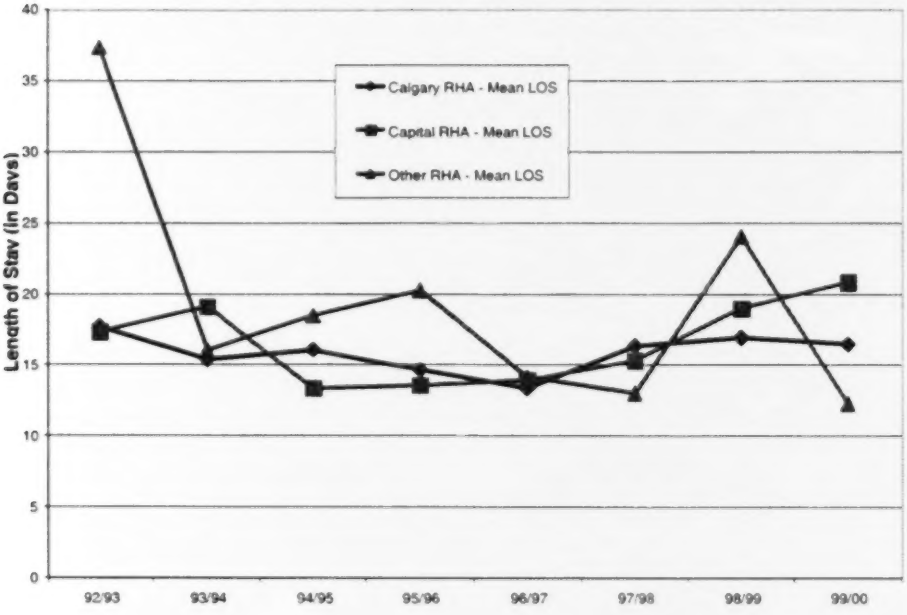


Figure 19 – Surgical Activity for Ligation and Stripping of Veins

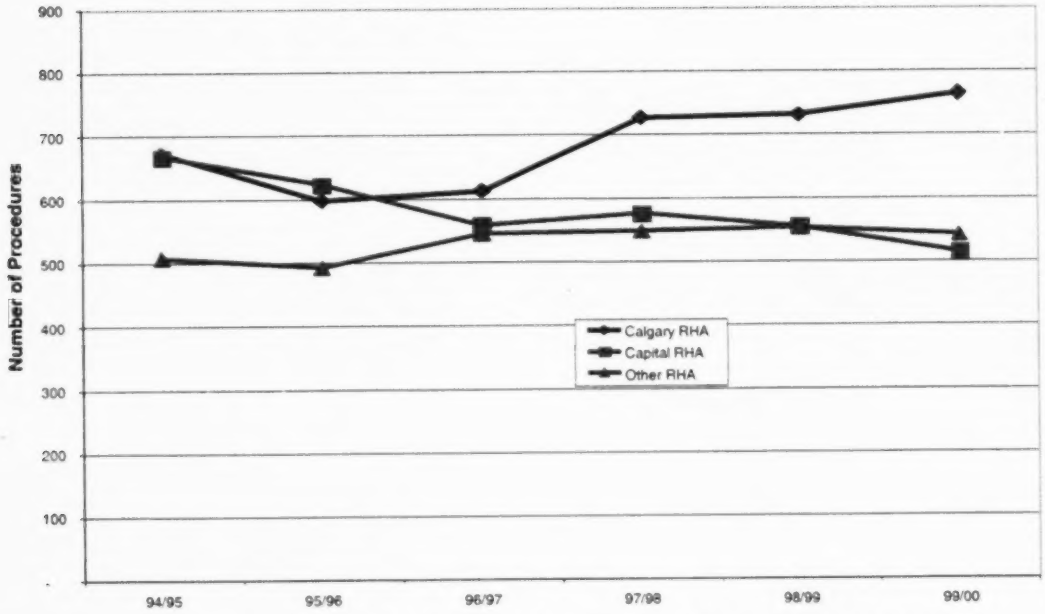


Figure 20 – Average Inpatient LOS for Ligation and Stripping of Veins

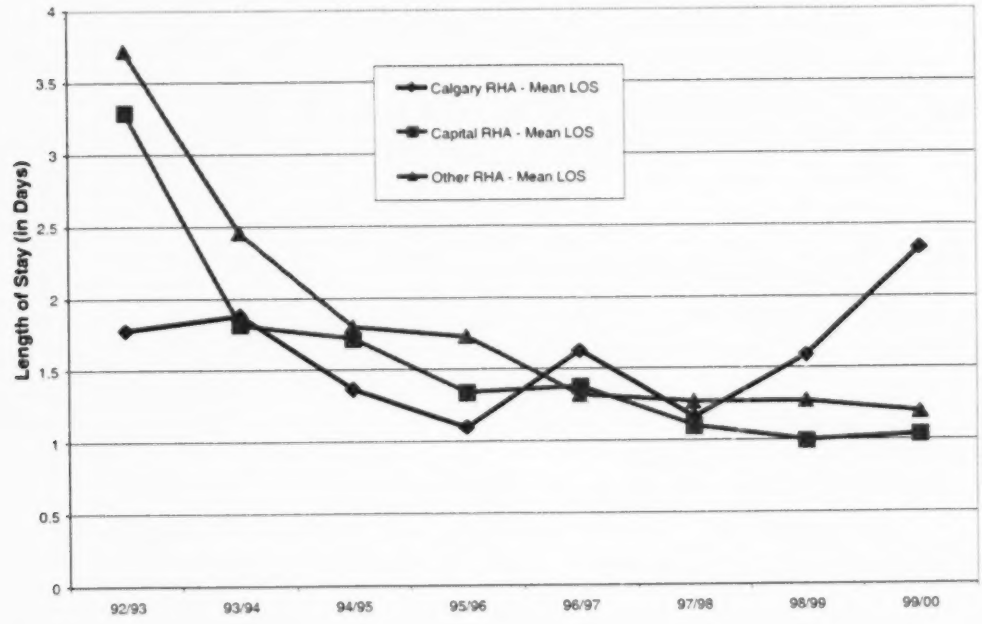


Figure 21 – Surgical Activity for Thoracotomies for Tumours

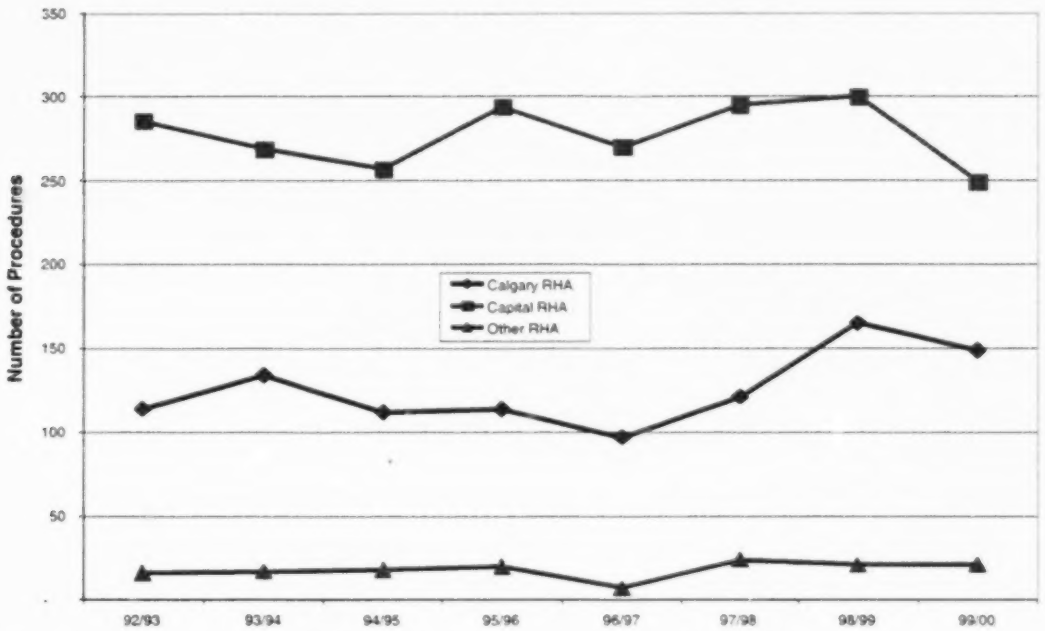


Figure 22 – Average Inpatient LOS for Thoracotomies for Tumours

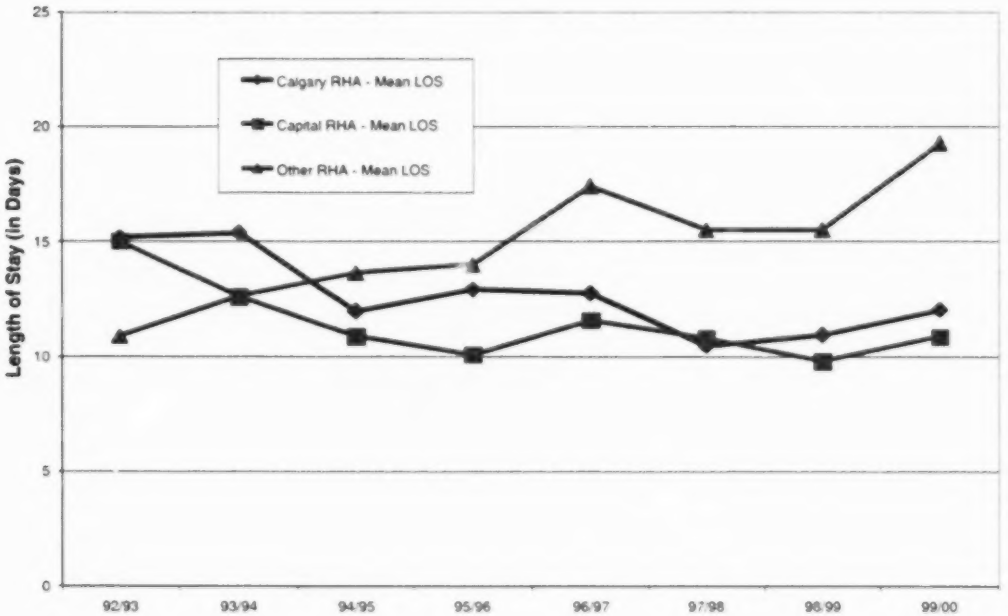


Figure 23 – Surgical Activity for Microvascular Free Tissue Transfers

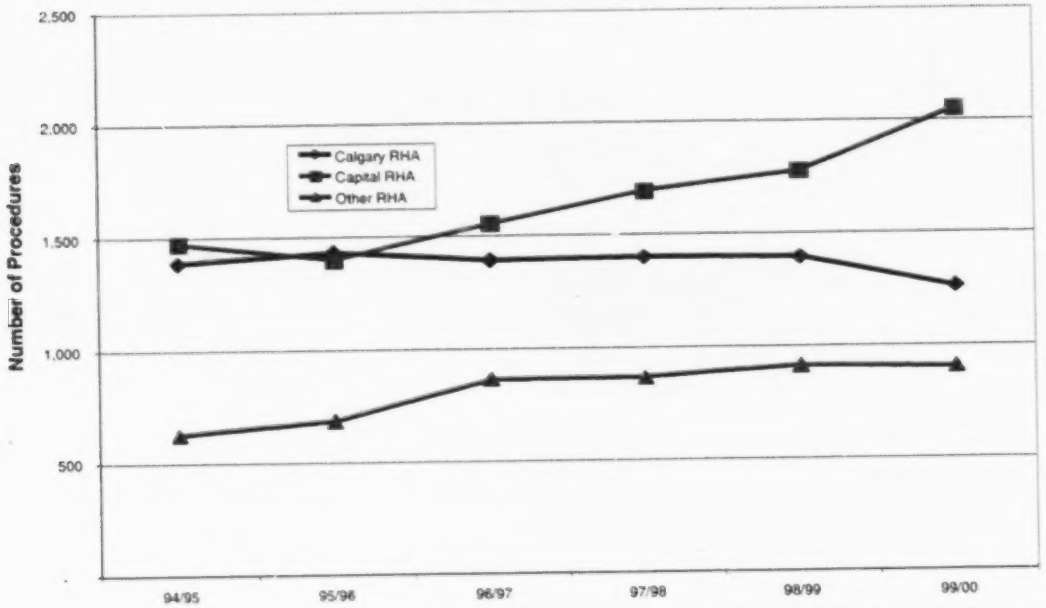


Figure 24 – Average Inpatient LOS for Microvascular Free Tissue Transfers

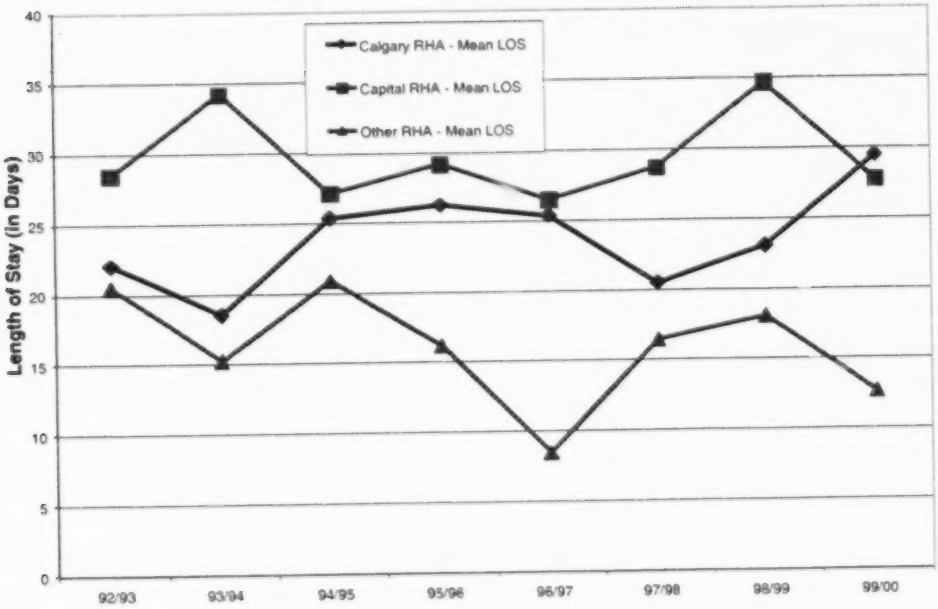


Figure 25 – Surgical Activity for Reduction Mammoplasties

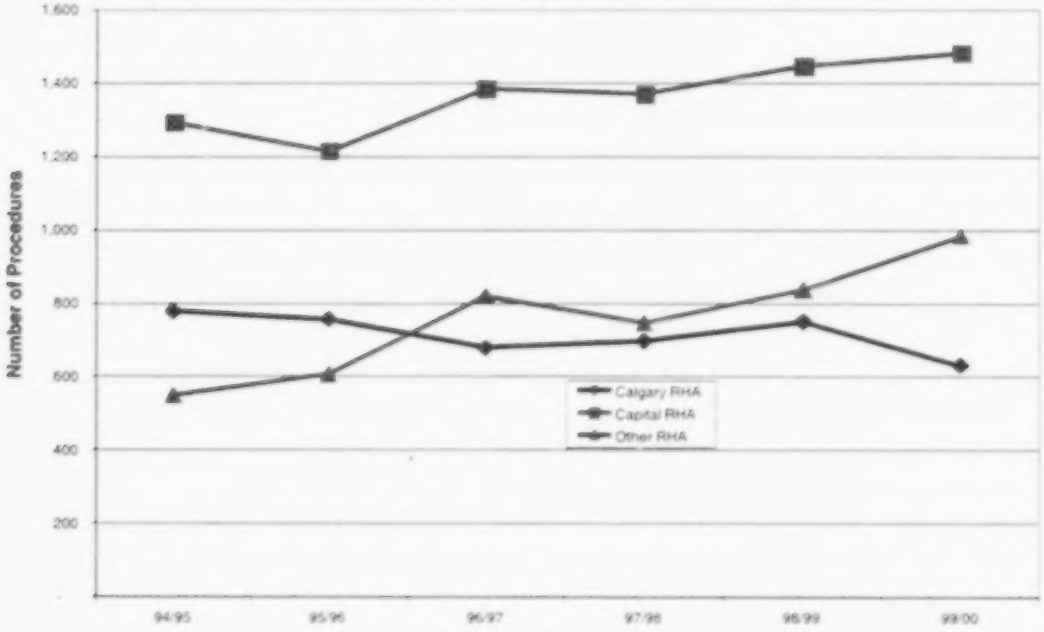


Figure 26 – Average Inpatient LOS for Reduction Mammoplasties

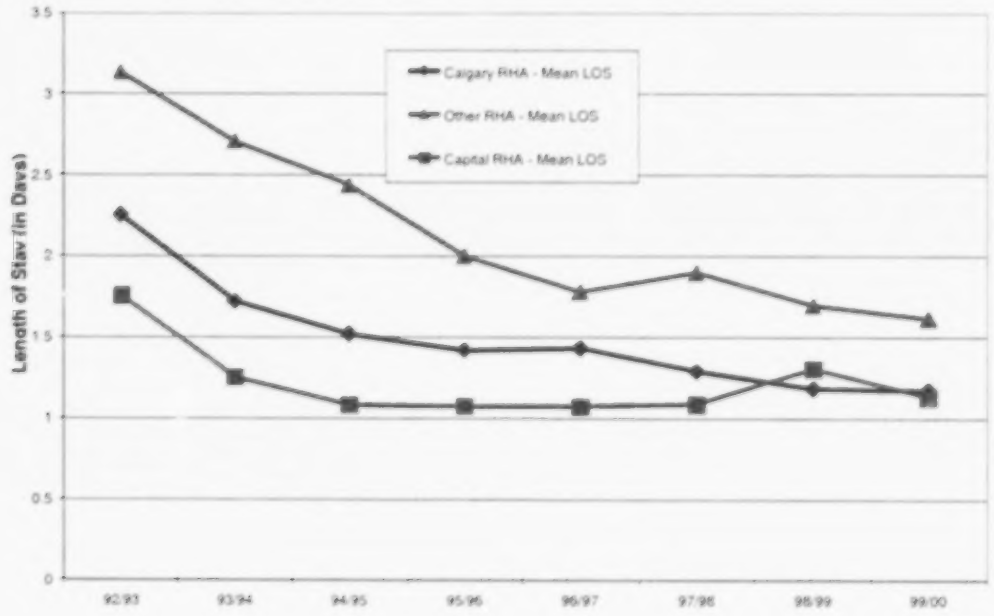


Figure 27 – Surgical Activity for Laryngectomies for Cancer

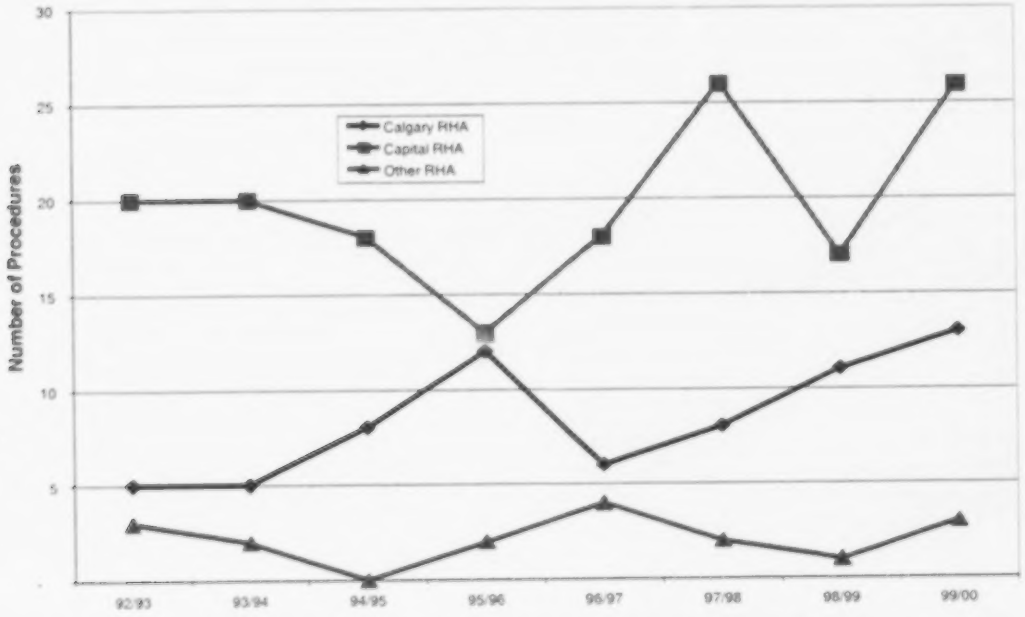


Figure 28 – Average Inpatient LOS for Laryngectomies for Cancer

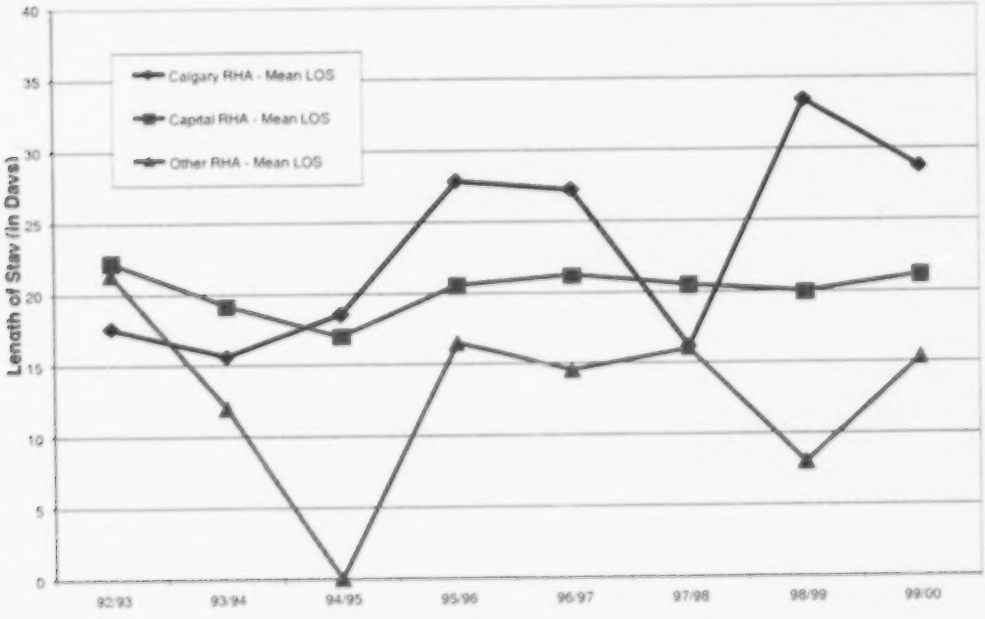


Figure 29 – Surgical Activity for Tonsillectomies / Adenoidectomies

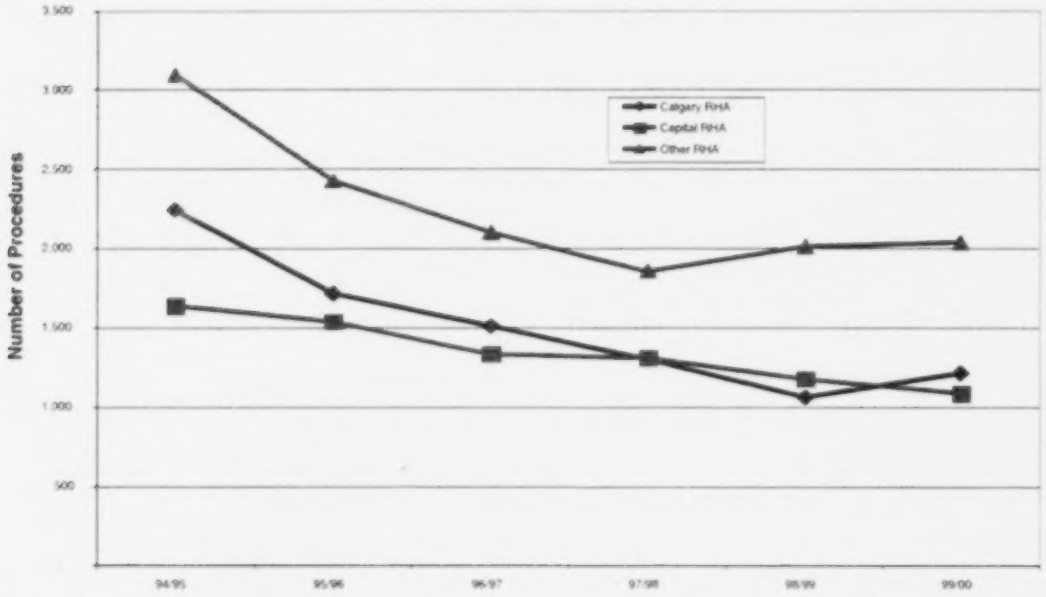


Figure 30 – Average Inpatient LOS for Tonsillectomies / Adenoidectomies

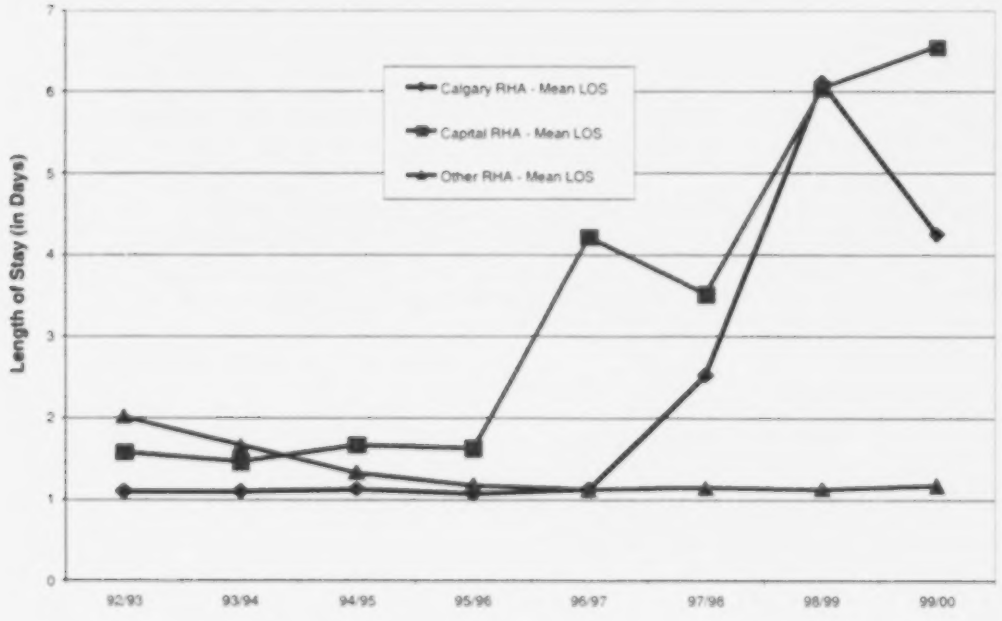


Figure 31 – Rate of Major In-hospital Complications Following Total Hip Replacement Procedures

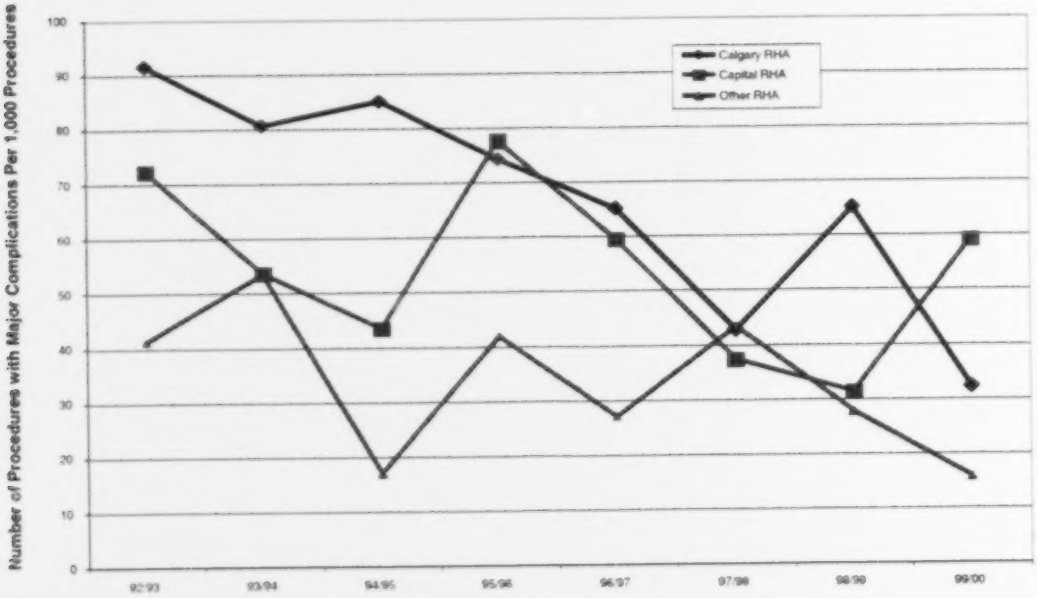


Figure 32 – Rate of Major In-hospital Complications Following Colon Resection for Cancer Procedures

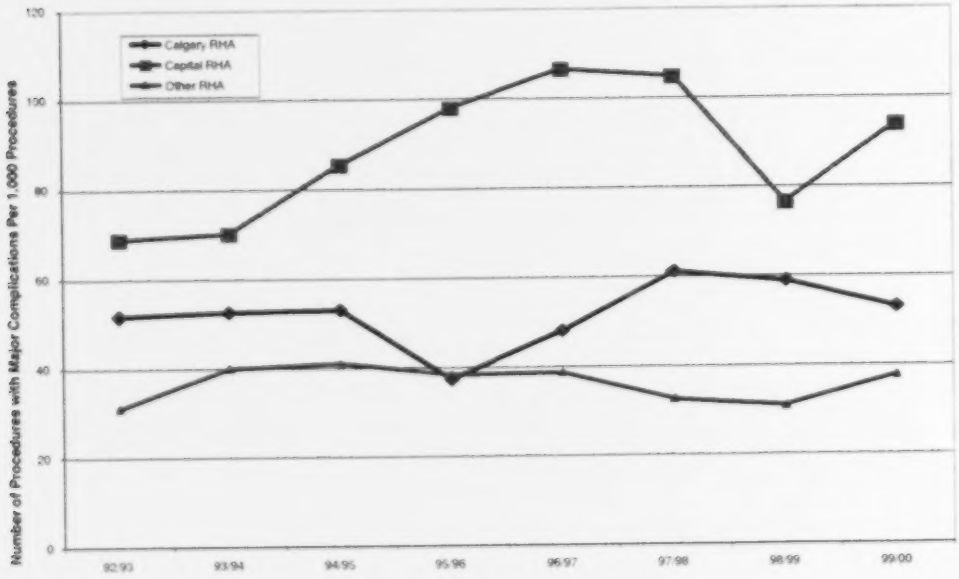


Figure 33 – Rate of Major In-hospital Complications Following Laparascopic Cholecystectomy Procedures

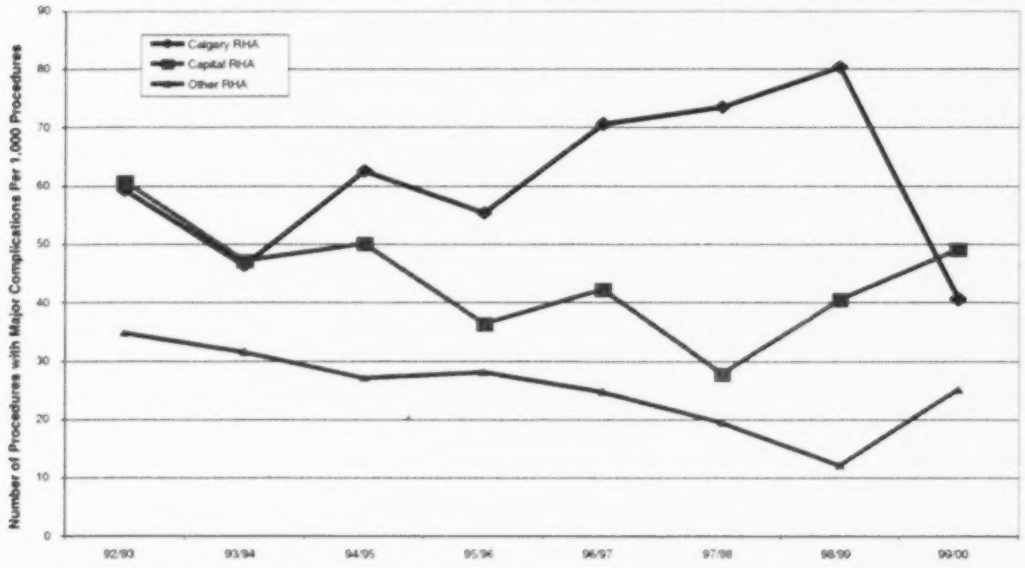


Figure 34 – Rate of Major In-hospital Complications Following Microvascular Free Tissue Transfer Procedures

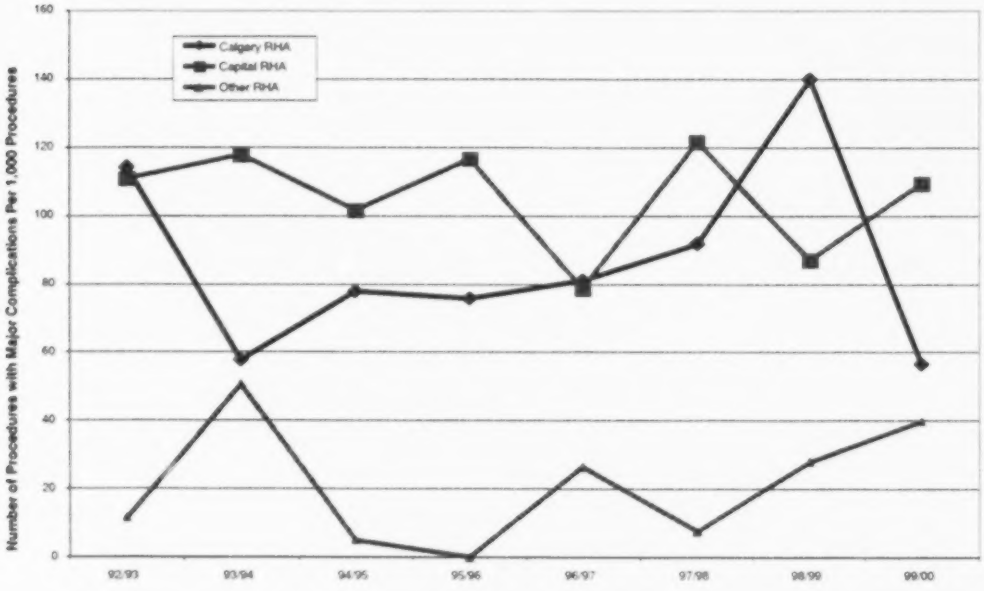


Figure 35 – Mean Wait (in Days) for Craniotomy for Tumour Procedures

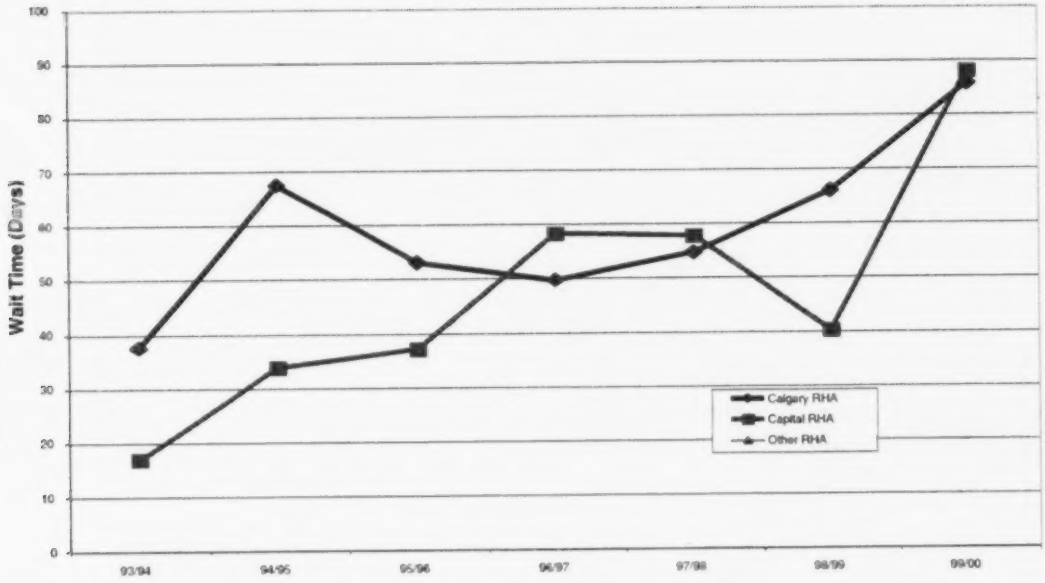


Figure 36 – Median Wait (in Days) for Craniotomy for Tumour Procedures

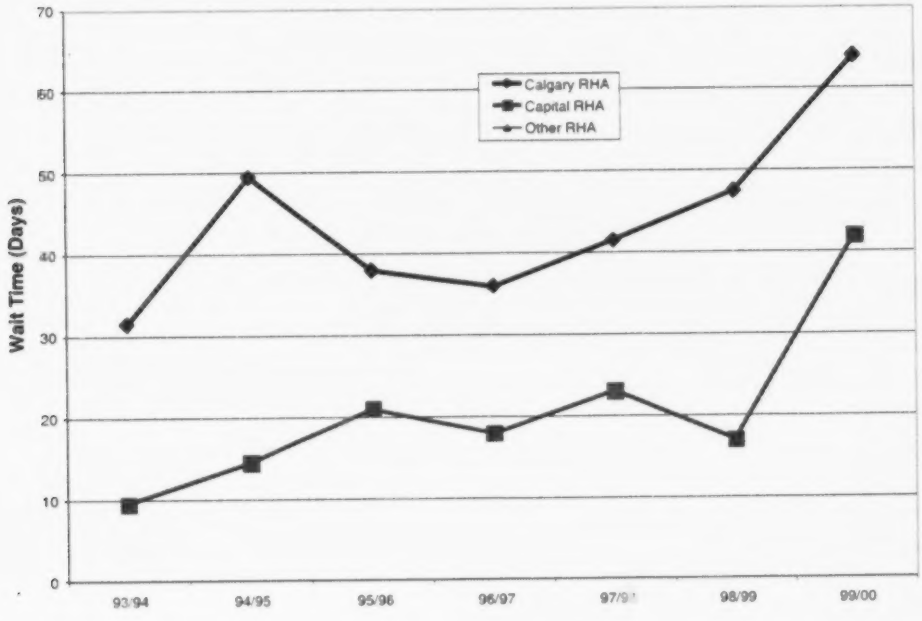


Figure 37 – Mean Wait (in Days) for Debulking for Ovarian Cancer Procedures

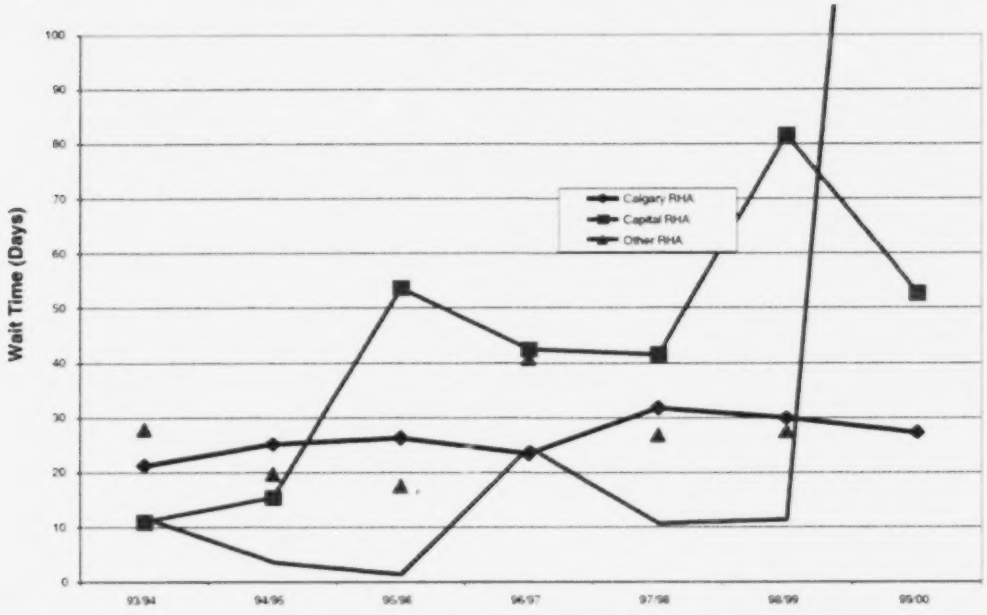


Figure 38 – Median Wait (in Days) for Debulking for Ovarian Cancer Procedures

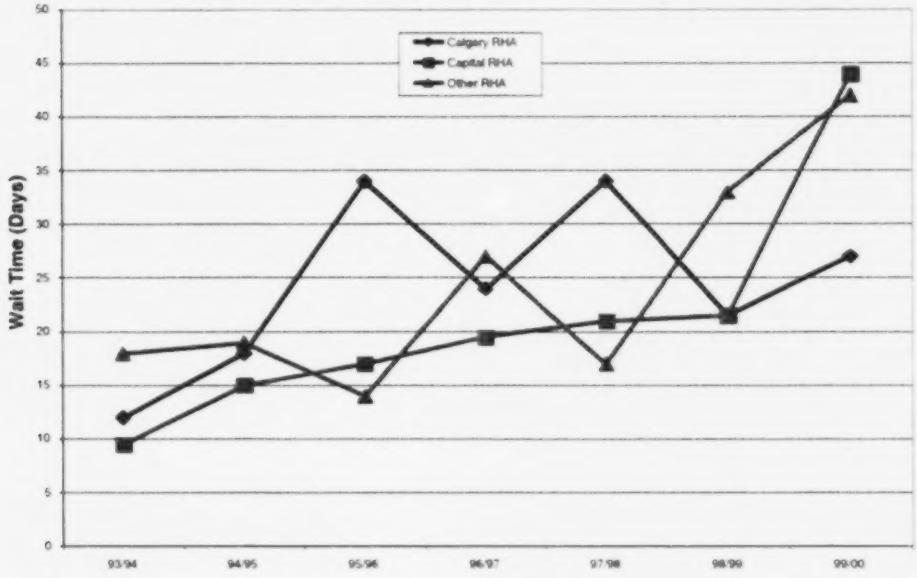


Figure 39 – Mean Wait (in Days) for Total Hip / Knee Replacement Procedures

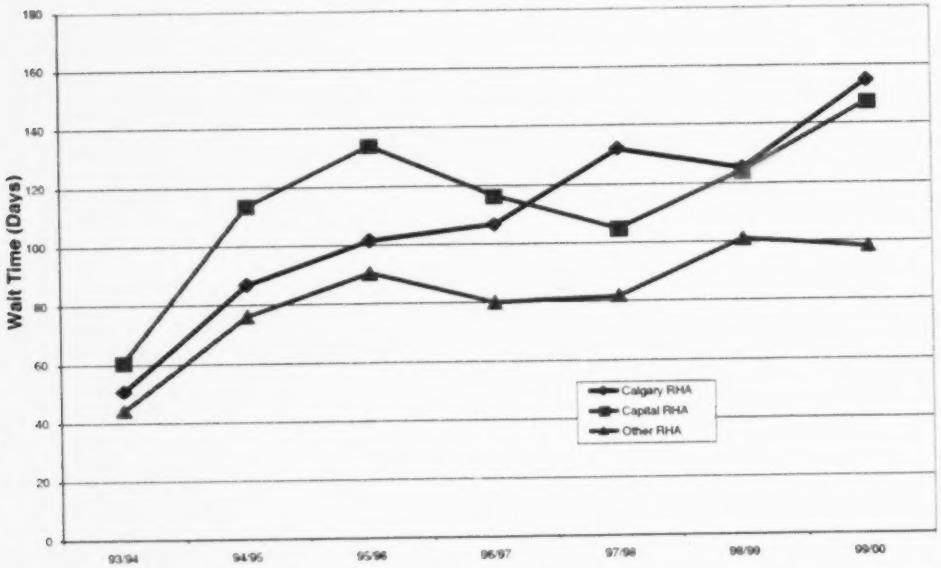


Figure 40 – Median Wait (in Days) for Total Hip / Knee Replacement Procedures

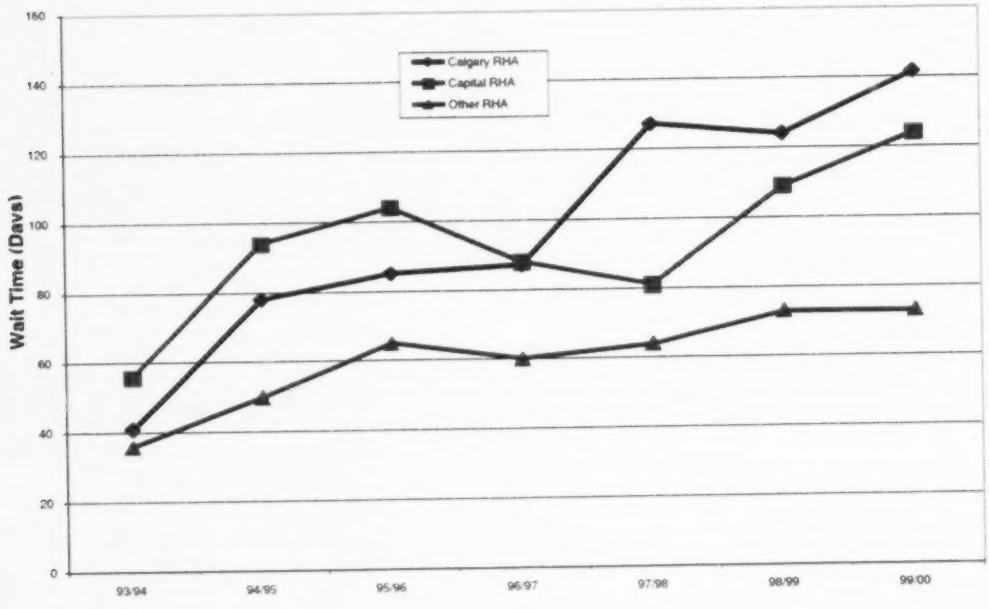


Figure 41 – Mean Wait (in Days) for Colon Resection for Cancer Procedures

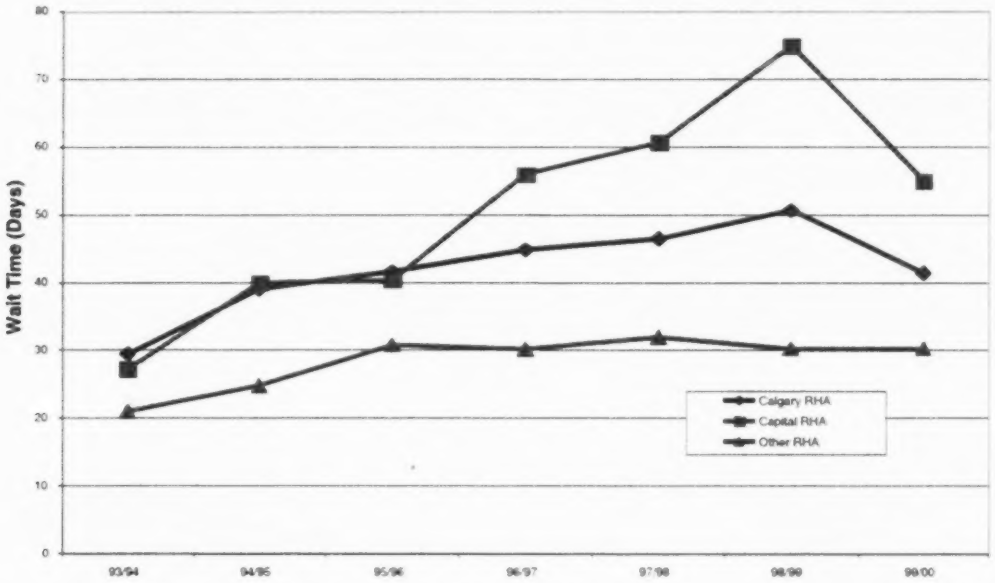


Figure 42 – Median Wait (in Days) for Colon Resection for Cancer Procedures

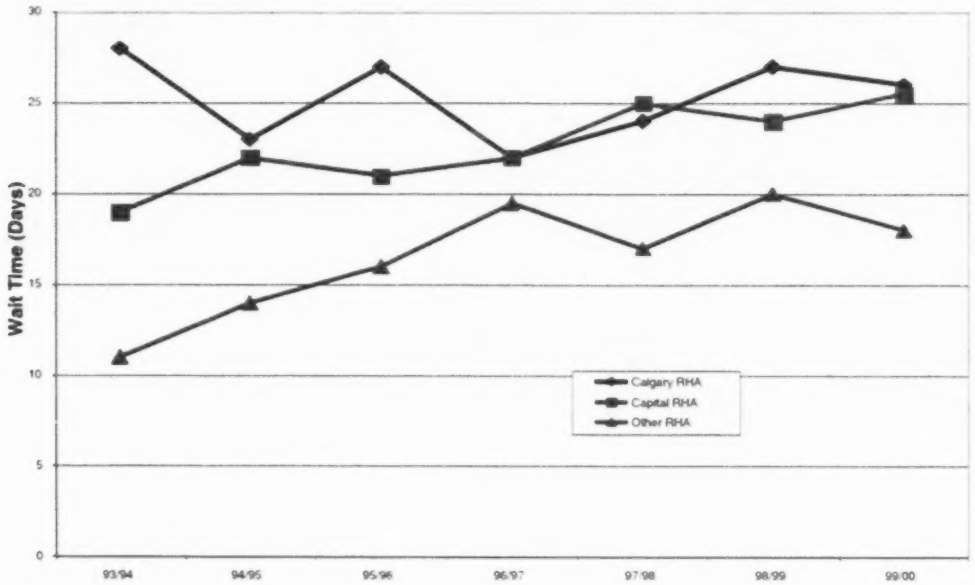


Figure 43 – Mean Wait (in Days) for Laparoscopic Cholecystectomy Procedures

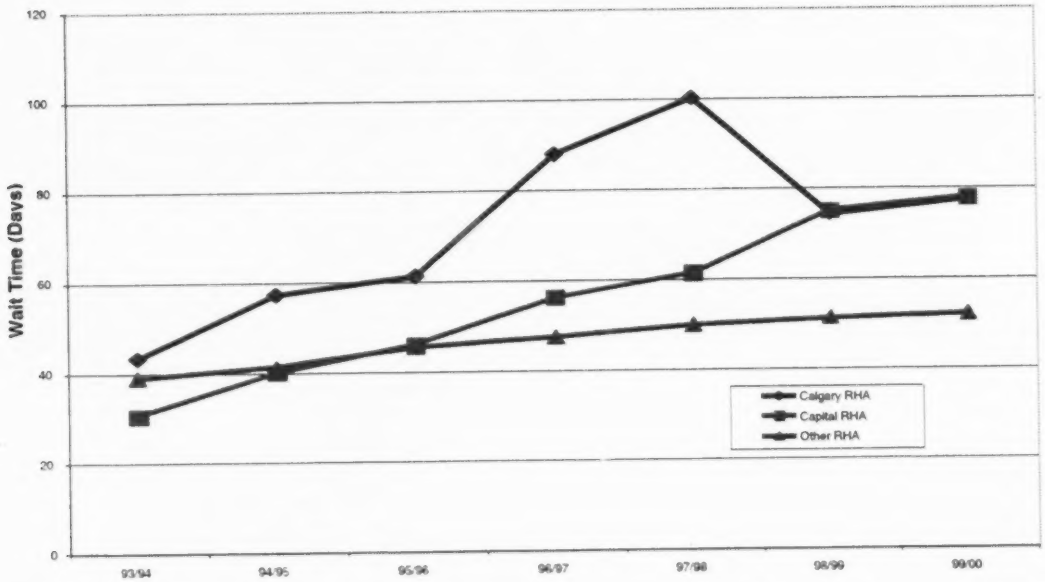


Figure 44 – Median Wait (in Days) for Laparoscopic Cholecystectomy Procedures

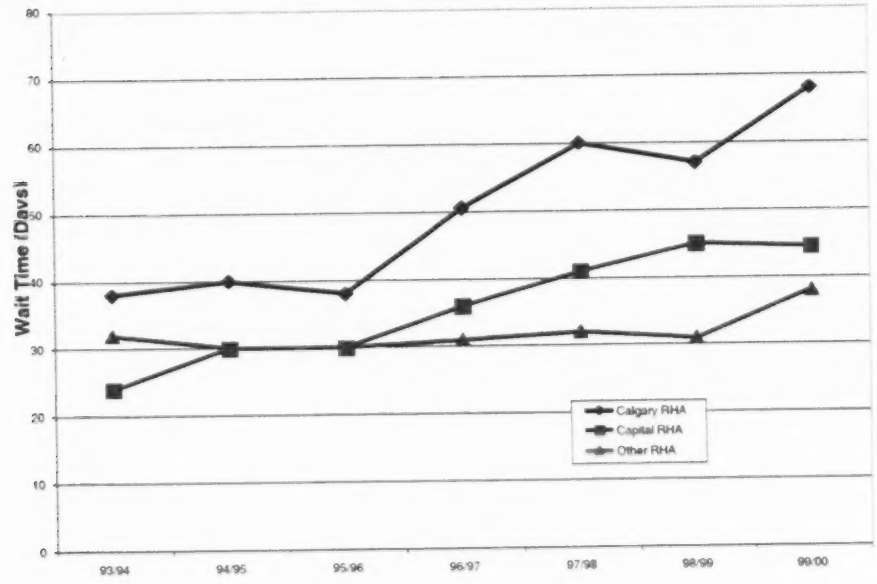


Figure 45 – Mean Wait (in Days) for Nephrectomy for Tumour Procedures

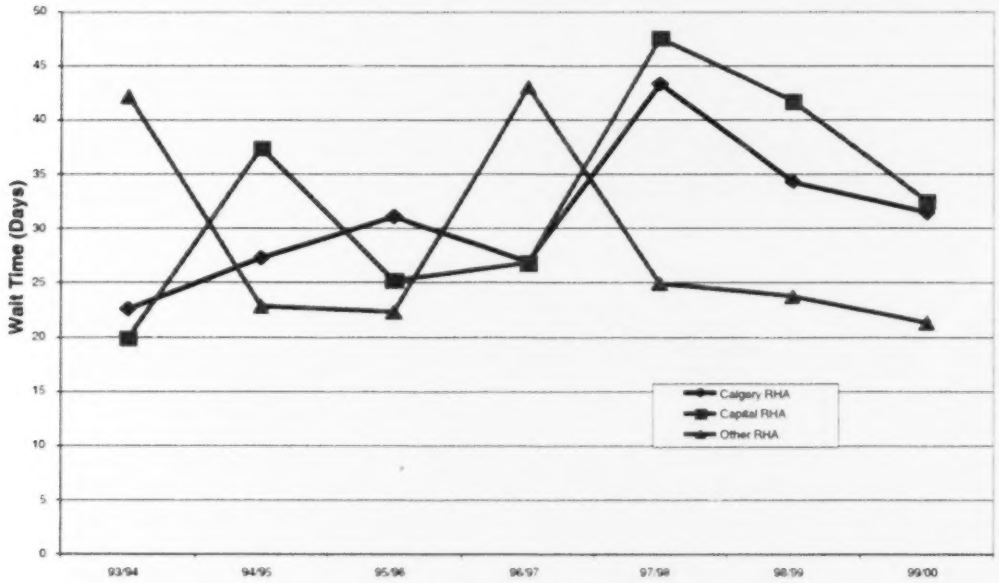


Figure 46 – Median Wait (in Days) for Nephrectomy for Tumour Procedures

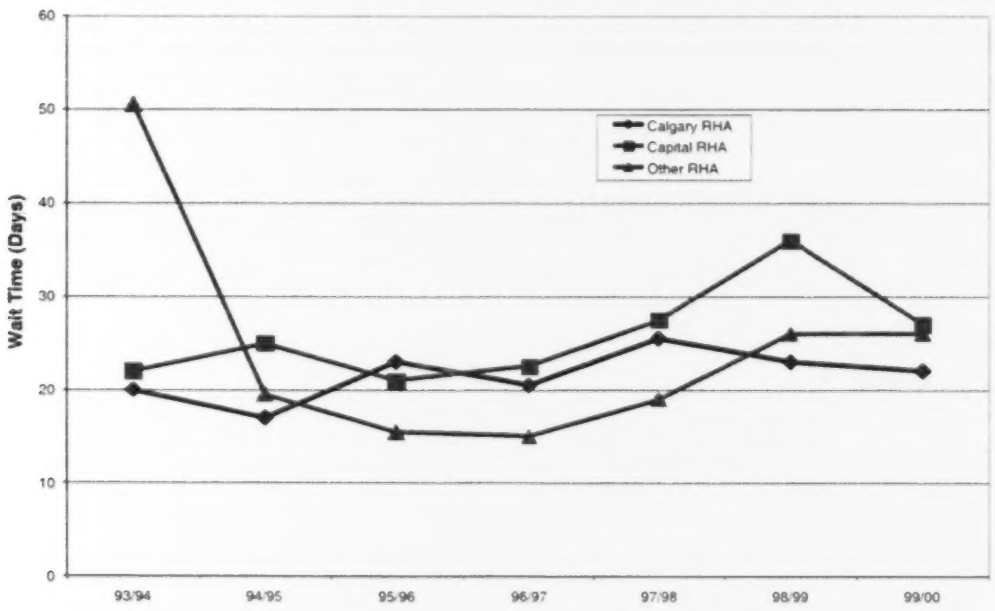


Figure 47 – Mean Wait (in Days) for TURP Procedures

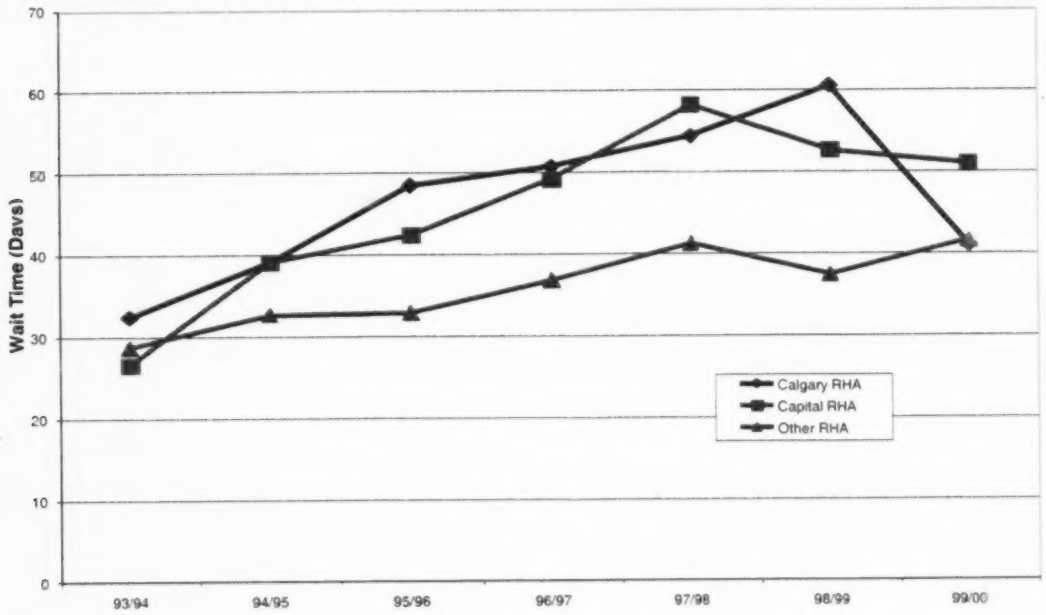


Figure 48 – Median Wait (in Days) for TURP Procedures

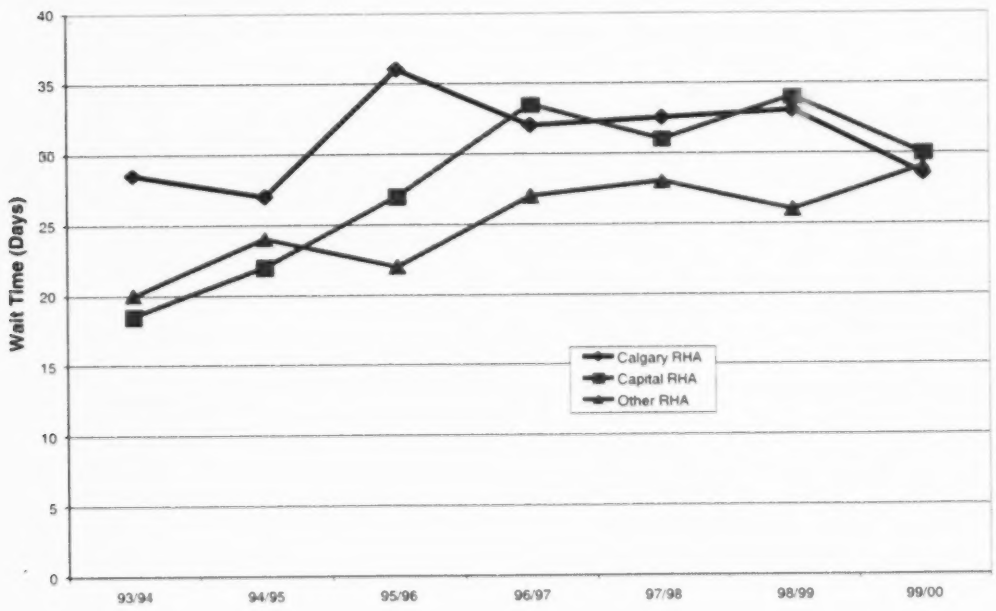


Figure 49 – Mean Wait (in Days) for Abdominal Aortic Aneurysm Procedures

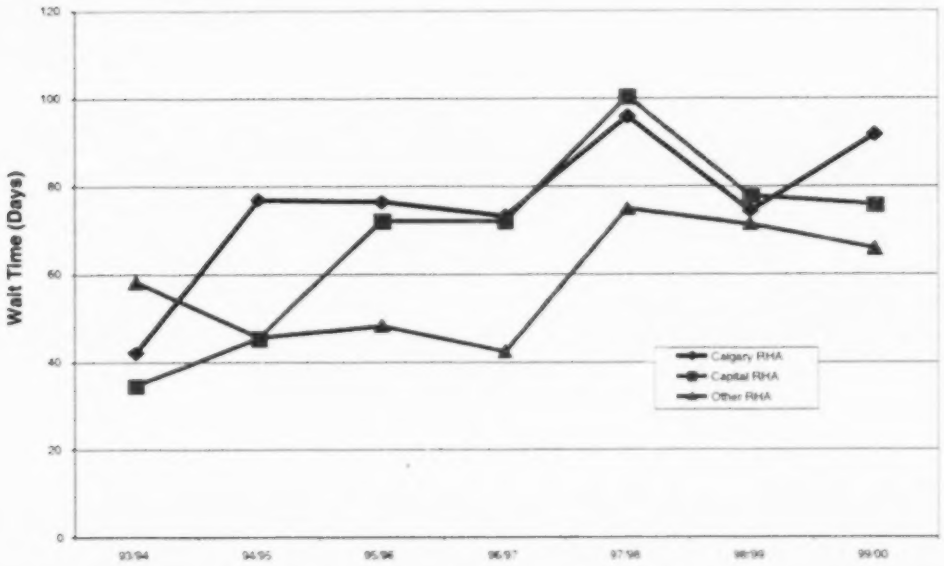


Figure 50 – Median Wait (in Days) for Abdominal Aortic Aneurysm Procedures

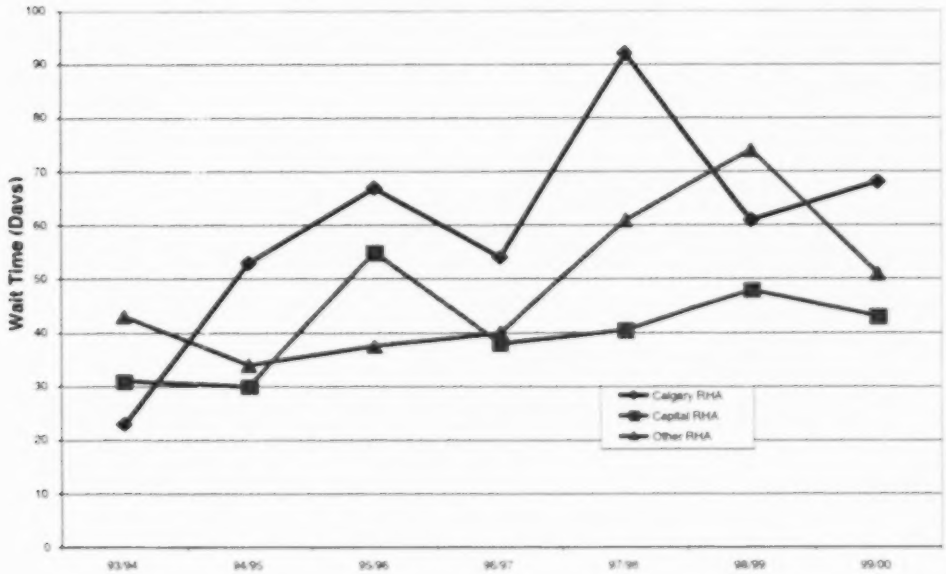


Figure 51 – Mean Wait (in Days) for Thoracotomy for Tumour Procedures

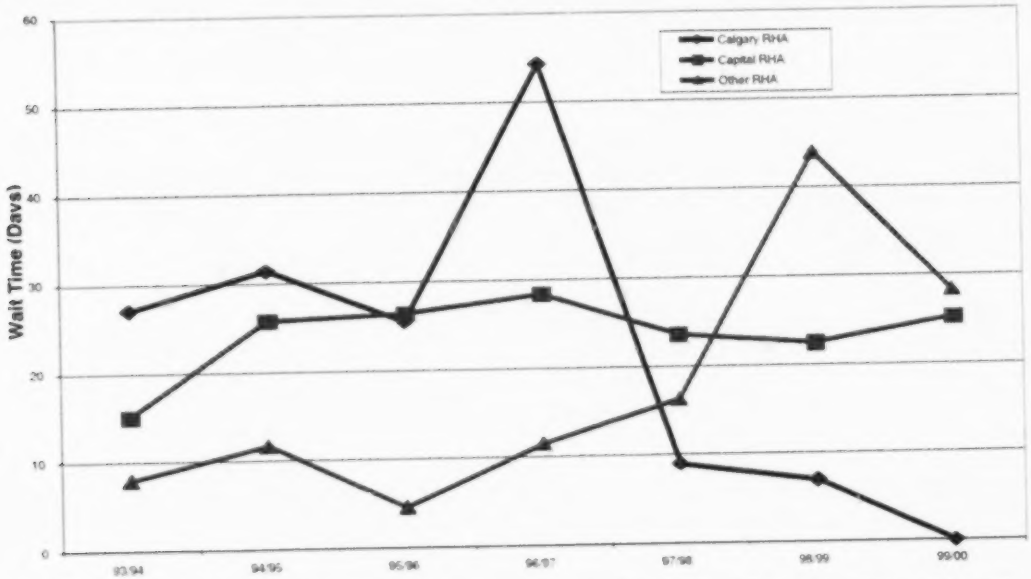


Figure 52 – Median Wait (in Days) for Thoracotomy for Tumour Procedures

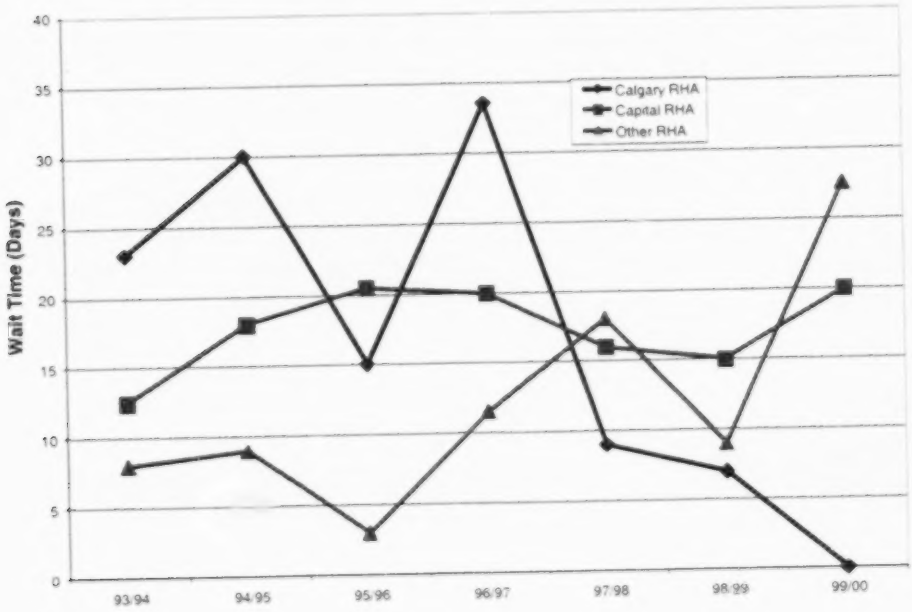


Figure 53 – Mean Wait (in Days) for Laryngectomy for Cancer Procedures

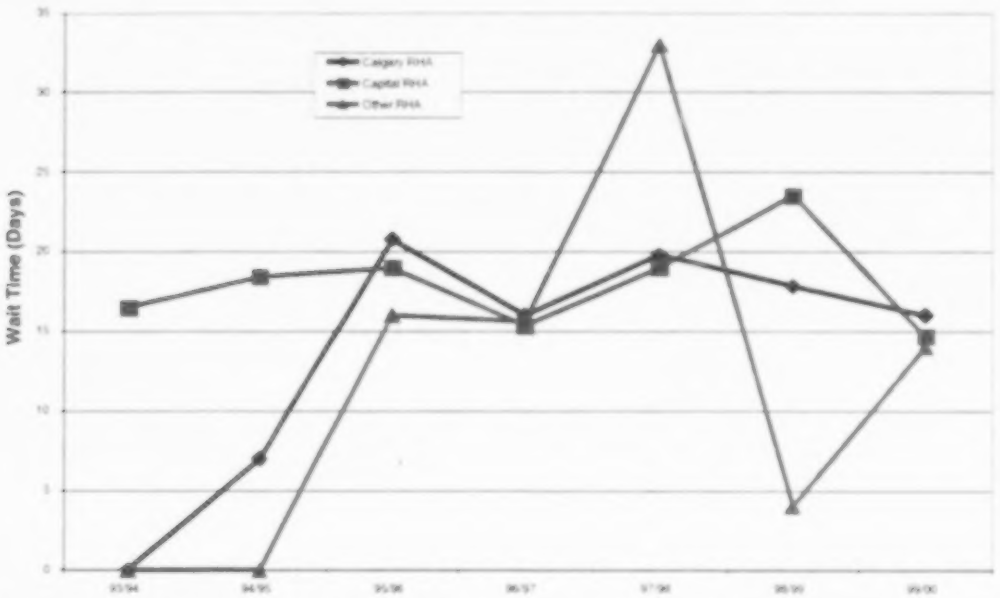
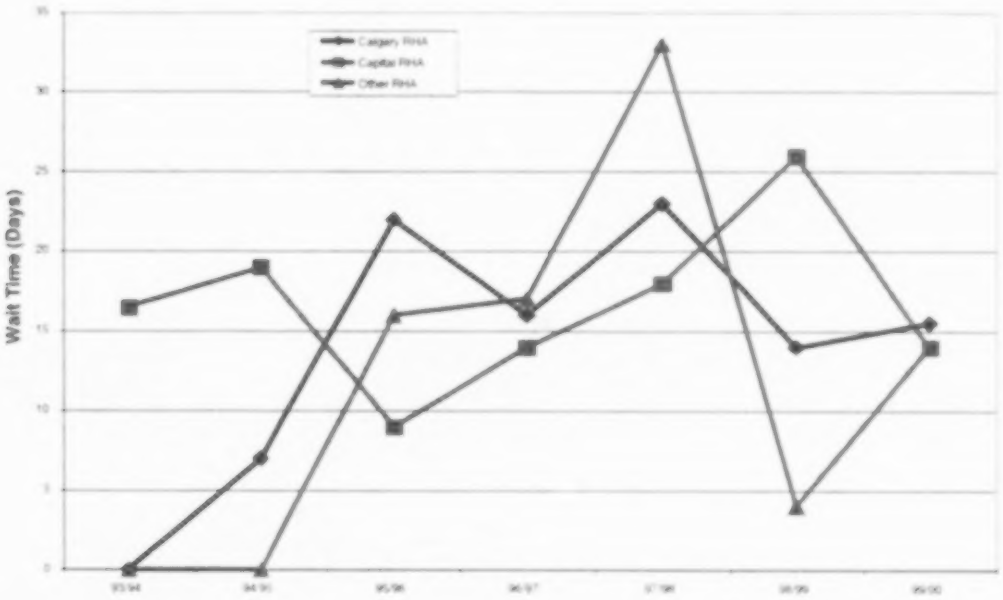


Figure 54 – Median Wait (in Days) for Laryngectomy for Cancer Procedures



BIOGRAPHIES

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Bachelor of Science, University of British Columbia

Master of Health Services Administration, University of Alberta

Associate Director, Centre for Health Outcomes Research and Utilization Studies, University of Alberta.

In his current position, Arif Alibhai is involved in developing and managing research projects for the Centre for Health Outcomes Research and Utilization Studies (CHORUS). He is also involved in conducting database analyses. His interests lie in Health Services Research and the analysis of large databases.

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Masters in Medical Sciences, University of Alberta

Senior Data Analyst, Centre for Health Outcomes Research and Utilization Studies (CHORUS), University of Alberta.

As the data analyst at CHORUS, Ms. Thanigasalam applies her training in epidemiological and statistical methods in the analysis of health administrative and clinical databases. She completed her Masters in Medical Sciences with a specialization in Epidemiology in January, 2001 at the University of Alberta.

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Stewart Hamilton, M.D., FRCSC, FACS

Bachelor of Arts, McGill University

M.Sc., Experimental Surgery, University of Alberta

M.D.C.M., McGill University

Walter Stirling Anderson Professor and Chair, Department of Surgery, University of Alberta

Dr. Hamilton joined the surgical staff at the University of Alberta Hospital in 1985, following Fellowship Training in Critical Care and Trauma. Prior to his assuming the Chair of the Department of Surgery in 1993, he was the Director of the Critical Care Program at the University of Alberta Hospital and Program Director for the Training Program in General Surgery, accredited by the Royal College of Physicians and Surgeons of Canada.

Since taking on the role of Chair of the Department of Surgery at the University of Alberta, and Chief of Surgery at the University of Alberta Hospital, Dr. Hamilton has had extensive involvement in surgical service planning and delivery. In 1996, he was elected as a member of Council of the Royal College of Physicians and Surgeons of Canada and served as a member of the Executive Committee of that organization from 1998 to 2002 as Vice-President, Corporate Affairs. In 2002, Dr. Hamilton was elected to the Council of the Canadian Medical Protective Association and recently joined its Executive Committee. Dr. Hamilton remains active in clinical practice as a Gastrointestinal Surgeon and in the teaching programs of the Faculty of Medicine at the University of Alberta.

Dr. Hamilton is a Fellow of the Royal College of Physicians and Surgeons of Canada, a Fellow of the American College of Surgeons and a member of numerous professional societies, including the Trauma Association of Canada (of which he was President in 1990), the Canadian Association of General Surgeons and the Western Surgical Association.

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MBBCh, University of the Witwatersrand, Johannesburg, South Africa

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Professor of Epidemiology, Department of Public Health Sciences, Faculty of Medicine, University of Alberta

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Dr. Duncan Saunders worked as a physician and epidemiologist in South Africa before becoming an Epidemic Intelligence Service (EIS) Officer with the Centres for Disease Control and Prevention, US Public Health Service, Atlanta, Georgia assigned to the California Department of Health Services. He later served as Director, Non-Infectious Disease Epidemiology in the San Francisco Department of Public Health before coming to the University of Alberta in 1989. In California, he was involved in the investigation of a number of disease outbreaks possibly related to environmental hazards; in the investigation of cancer cluster investigations; in injury surveillance and in a study of AIDS and cancer. Since coming to Alberta, he has continued to work in the fields of health services research and injury epidemiology. He was a principal investigator and co-author of major reports on redesigning local environmental health programs and on community-based health services delivery for Alberta Health and Health Canada respectively. Dr. Saunders has a particular interest in evidence-based decision-making in health care and teaches classes in evidence-based health care.

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Vice-Dean, Faculty of Medicine and Dentistry, University of Alberta

Professor, Department of Medicine, University of Alberta

Dr. Bear served as Executive Vice-President, Chief Clinical Officer, Capital Health Authority and Associate Dean, Clinical Affairs, Faculty of Medicine and Dentistry, University of Alberta from December 1997 to June 30, 2001. Prior to that, Dr. Bear served as Executive Vice-President and Chief Clinical Officer, St. Michael's Hospital from 1992 to 1997. In these roles, Dr. Bear took a leadership role in developing educational and administrative policies and programs.

Dr. Bear completed his medical degree at the University of Toronto. He completed his internship and served as an assistant resident at St. Michael's Hospital in Toronto. After serving as an assistant resident, and then Chief Resident at Boston City Hospital, proceeded to New England Medical Centre, Tufts University School of Medicine as a Clinical Fellow in Nephrology. Following that, Dr. Bear became a Research Fellow in Nephrology at Peter Bent Brigham Hospital, Harvard School of Medicine.

Dr. Bear is a Fellow of the Royal College of Physicians and Surgeons of Canada, and of the American College of Physicians. He is also a Diplomate of the American Board of Internal Medicine and the American Board of Nephrology. He has been granted a Diploma of Special Competence in Nephrology by the College of Physicians and Surgeons of Canada, and is a Certified Healthcare Executive of the Canadian College of Health Service Executives.

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